Model LRS-10

Optical Disk Subsystem

Technical Manual

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REVISION HISTORY

ECO No.	Date	Description	Pages
1169	10/11/88	Manual Release	

PREFACE

This manual contains information regarding installation, testing, and operation of the ZETACO LRS-10 Optical Storage Subsystem. It has been written with the following assumptions in mind: 1) You have a working knowledge of Data General (DG) minicomputers, operating systems, and diagnostic and utility software; 2) you have access to full hardware and software documentation for your particular system; 3) you are familiar with standard installation, power, grounding, and peripheral cabling procedures.

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

SECTION 1.0 PRODUCT OVERVIEW - Describes the LRS-10 features, capabilities, specifications, power, and interface requirements.

SECTION 2.0 INSTALLATION PROCEDURES - Describes and illustrates the procedures required to install the LRS-10.

SECTION 3.0 USAGE GUIDELINES - Discusses the unique features of optical storage and their practical application with the LRS-10.

SECTION 4.0 TROUBLE-SHOOTING - Contains information useful in analyzing subsystem problems, and how to get help.

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1.0 PRODUCT OVERVIEW

1.1 GENERAL DESCRIPTION

The LRS-10 Optical Storage Subsystem is a digital data storage and retrieval system designed for interface with DG BMC-equipped minicomputers. It utilizes Write-Once Read-Many (WORM) optical disk technology. Data is stored on a removable double-sided optical platter with an approximate capacity of one gigabyte per side.

The subsystem is composed of a controller, a cached optical drive that is both readable and writable, and up to three additional optical drives that are read-only. The cached optical drive consists of an optical drive, and a Winchester magnetic disk drive that acts as the cache.

The controller pairs ZETACO's emulation of the DG Argus 6236/6239 Disk Subsystem with the SCSI peripheral interface on a single 15" x 15", 10-layer printed circuit board. Data transfers take place over the Burst Multiplexor Channel (BMC) on DG's Eclipse and MV Series computers.

ZETACO provides a rack-mountable enclosure to house the magnetic drive and its power supply. The optical disk drives are also rack-mountable. All components are connected by a daisy-chain cabling system designed tc meet FCC shielding requirements.

1.2 FEATURES AND ADVANTAGES

* Single controller is compatible with DG's full range of BMC-equipped computers
* Simultaneous control of up to four optical disk drives, for a total of 4 gigabytes of on-line data
* Device code is easily selected, even after installation, via switches accessible at the board edge
* High speed dual-microprocessor design and BMC Ping-Pong buffering support maximum transfer rates with minimum controller latency
* On-board self-test with error reporting and LED display
* Removable optical media, in the form of cartridges
* On-board Sector Scrub/Append allows data already stored on an optical disk to be "re-written"
* Magnetic disk cache minimizes need to scrub sectors
* Media management entirely resident on controller
* User-friendly software configuration

1.3 SPECIFICATIONS

1.3.1 LRS-10 CONTROLLER

1.3.1.1 FUNCTIONAL - GENERAL

Drives per Controller:	Up to 5 SCSI drives: 1 magnetic, up to 4 optical	
Maximum On-line Capacity:	4 Gb: 1 Gb Read/Write, 3 Gb Read-Only	
Transfer Rate:	Maximum SCSI burst rate of 1 Mb/second	
Indicator Lights:	Red (Left):	Self-Test - SCSI Module
	Red (Right):	Self-Test - HOST Module
	Yellow:	Self-Test - CABLE Module
	Green (Left):	SCSI Busy
	Green (Right):	Host Busy
Device Code Selection:	Switch-selectable	

1.3.1.2 FUNCTIONAL - COMPUTER INTERFACE

DG Emulation: 6236/6239 Disk Subsystem

Bus Load: 1 unit load (any I/O slot)

Data Channel Interface: Not supported

Burst Multiplexor Channel (BMC) Interface:

- less than 1 STTL load
- 64ma drive at 0.7v
- supports selectability of any of the 8 priority requests
- selectable burst rates of 1 to 256, 16-bit words/access
- selectable break between access of 1-256 sync clock periods
- Maximum allowable BMC latency is 30ms.
- supports transfer rates equal to the fastest available BMC computers (16.16 Mbyte/sec)

1.3.1.3 FUNCTIONAL - DRIVE INTERFACE

Small Computer Systems Interface (SCSI):

- supports parity generation and checking
- complies with "Common Command Set"
- Byte-wide parallel data bus

1.3.1.4 MECHANICAL

Controller Dimensions:

Width:	15 inches (38.1 cm)
Length:	15 inches (38.1 cm)
Height:	0.5 inches (1.3 cm)

Shipping Weight: 10 pounds (4.5 kg) - includes controller, paddleboard, cables, Software Support Tape, and documentation

1.3.1.5 POWER REQUIREMENTS

+5 (+/- 5%) Volts DC @ 6.5 Amps typical

1.3.1.6 ENVIRONMENTAL

OPERATING ENVIRONMENT:

Temperature:	0 to +55 degrees C
Relative Humidity:	+10% to +90% (non-condensing)

NON-OPERATING ENVIRONMENT:

Temperature:	-45 to +115 degrees C
Relative Humidity	+10% to +90% (non-condensing)

Exceeds all Eclipse and Eclipse/MV temperature and humidity specifications.

1.3.2 MAGNETIC DISK DRIVE MODULE

1.3.2.1 FUNCTIONAL

Recording Technology:	Winchester (non-removable)
Interface:	SCSI
Capacity (Formatted):	155.9 MB
Tracks per Surface:	969
# of Platters:	5
# of Data Surfaces:	9
Rotational Speed:	3600 RPM
Rotational Latency:	8.33 ms
Transfer Rate:	1.25 MB/sec
Access Time:	Track to Track: 5 ms Average: 18 ms Full Stroke: 43 ms

1.3.2.2 MECHANICAL

Enclosure Dimensions:	
Width:	19 inches (48.26 cm)
Height:	3.4 inches (8.6 cm)
Length:	15 inches (38.1 cm)
Shipping Weight:	32 pounds (14.5 kg)

1.3.2.3 POWER REQUIREMENTS

AC Input:	120 Volts
Frequency:	60 Hz
Max. AC Operating Current:	1.5 Amps
Fuse:	3 Amp Slo-Blo

1.3.2.4 ENVIRONMENTAL

OPERATING ENVIRONMENT:

Temperature:	+10 to +50 degrees C
Relative Humidity:	+10% to +80% (non-condensing)
Altitude:	-1000 to +10000 ft

NON-OPERATING ENVIRONMENT:

Temperature:	-34 to +60 degrees C
Relative Humidity:	5% to +95% (non-condensing)
Altitude:	-1000 to +40000 ft

1.3.3 OPTICAL DRIVE MODULE

1.3.3.1 FUNCTIONAL

Data Cartridge Storage Capacity (per Side):	1048 MB
Minimum Usable Capacity (per Side):	1000 MB
Tracks per Side:	32000
Sectors per Track:	32
Bytes per Sector:	1024
Average Access Time:	150 ms
Maximum Track Seek:	330 ms
Rotational Speed:	480 RPM
Average Rotational Latency:	62.5 ms
Maximum Rotational Latency:	127.6 ms
Average Data Transfer Rate:	262 KB/sec

Burst Data Transfer Rate (Read Mode):	1.33 MB/sec
SCSI Data Buffer:	44 Sectors

1.3.3.2 MECHANICAL

Dimensions	
Width:	19 Inches (48.26 cm)
Height:	5.3 Inches (13.5 cm)
Depth:	25.6 Inches (65 cm)
Weight:	55 Pounds (25 kg)

1.3.3.3 POWER REQUIREMENTS

AC Input:	120 Volts @ 3 Amps
Frequency:	60 Hz

1.3.3.4 ENVIRONMENTAL

OPERATING ENVIRONMENT:

Temperature:	+10 to +40 degrees C
Relative Humidity:	+20% to +80% (non-condensing)
Altitude:	-983 to +8200 ft

NON-OPERATING ENVIRONMENT:

Temperature:	-40 to +60 degrees C
Relative Humidity:	+5% to +95% (non-condensing)

1.3.4 CABLING

1.3.4.1 INTERNAL

Paddleboard:	Passive backplane paddleboard with one 50-pin cable connector ("A" backplane)
Cable:	50-conductor flat ribbon cable

1.3.4.2 EXTERNAL

Cables:

- 50-conductor shielded round cable connecting backpanel to Optical Drive
- 50-conductor shielded round cable connecting Optical Drive to Magnetic Disk Drive
- Optional 50-conductor shielded round cable(s) connecting additional optical drives

The maximum cumulative cable length allowable for a fully populated subsystem (4 optical drives) is 6 meters (single-ended), or 19.68 feet.

NOTE: Each LD1200 contains approximately 2 feet of internal SCSI cable and the LRM-1 (magnetic drive module) contains approximately 0.5 feet of internal cable.

2.0 INSTALLATION

2.1 BEFORE YOU BEGIN

This section contains the procedures necessary for proper installation of the LRS-10. We recommend that you read through it once in its entirety before you begin.

The following sections, beginning with 2.2, are in order of execution. In Sections 2.2 through 2.4 you will select a slot and device code for the Controller, establish slot priority and BMC termination, and install the board and paddleboard. Sections 2.5 and 2.6 cover rack-mounting of the modules and cable connections. Section 2.7 details the power-up sequence.

In Sections 2.8 through 2.15 you will use programs on the Software Support Tape (the 1/2" magnetic tape reel shipped with the LRS-10) to complete the installation. You will first configure the Controller, then format the Magnetic Disk Drive. Finally, you will run DFMTR on the subsystem and bring it into full system operation.

You will need the following tools to install the LRS-10:

1. A Phillips screwdriver
2. A set of nut drivers
3. A small straight-blade screwdriver
4. A large straight-blade screwdriver

You may also find a flashlight and needlenose pliers helpful for installing jumpers and the paddleboard in the computer backplane.

In the installation instructions we assume that you have on hand at least one blank data cartridge, which will become your first "active platter." In addition, we recommend that you have a second blank data cartridge to use as a Maintenance Platter. The procedure for creating a Maintenance Platter is covered in Appendix G.

NOTE: ONLY DATA CARTRIDGES MANUFACTURED BY OPTICAL STORAGE INTERNATIONAL (OSI) WILL WORK WITH YOUR OPTICAL DRIVE MODULE.

2.1.1 UNPACKING AND INSPECTION

The LRS-10 consists of the following parts:

QTY	DESCRIPTION	ZETACO P/N
1	Optical Disk Controller	500-471-00
1	Magnetic Disk Drive Module	850-008-00
1	Optical Drive Module	096-027-00
1	'A' Paddleboard	500-411-00
1	Internal Cable	300-148-00
1	External SCSI Cable 9'	300-152-03
1	External SCSI Cable 2'	300-152-04
1	BMC Terminator Block	300-156-00
2	BMC Bus Cables	300-038-00

In this procedure, we assume that you are installing an LRS-10 that has one optical drive.

Also shipped with the LRS-10 are:

1	Software Support Tape (9-track magnetic tape)	400-468-00
1	Subsystem Manual	600-469-00

Upon receipt of the LRS-10 from the carrier, inspect the shipping cartons immediately for any evidence of damage or mishandling in transit.

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

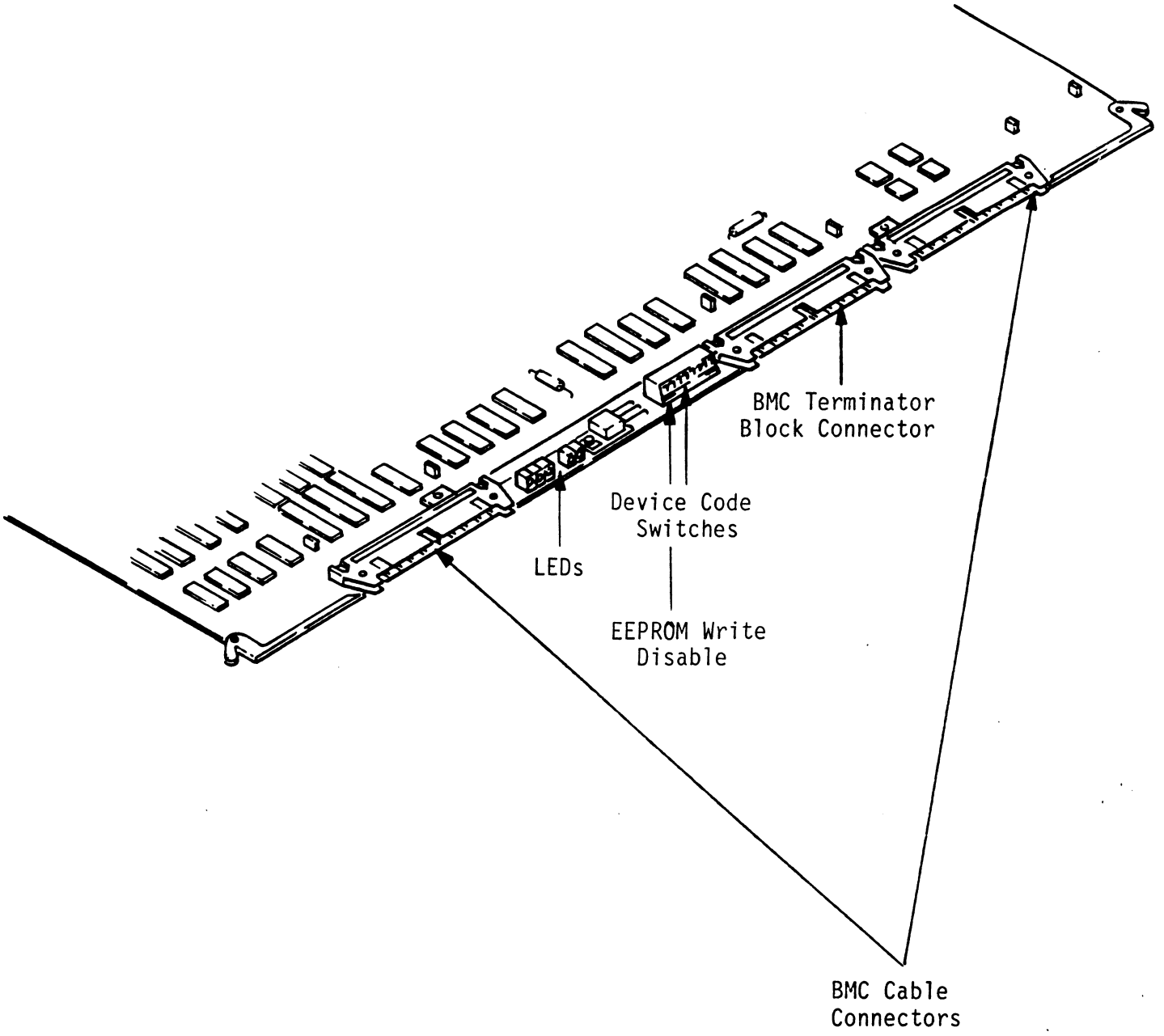
ZETACO'S warranty does not cover shipping damage.

For repair or replacement of any ZETACO product damaged in shipment, call ZETACO to obtain return authorization instructions. See Section 4.7.

2.1.2 SYSTEM HARDWARE REQUIREMENTS

a) Eclipse or MV Family CPU with minimum 32K words memory
b) Magnetic Tape Subsystem
c) Magnetic Disk Subsystem with system disk(s)
d) Console on Device 10/11
e) Printer at Device 17, in order to print a copy of your configuration facts and log any errors

FIGURE 2.1 Optical Disk Controller



2.1.3 THE SOFTWARE SUPPORT TAPE

The programs on the Software Support Tape have been written by ZETACO specifically for the LRS-10. You will use these programs to configure the Controller, format the magnetic disk, install Controller microcode onto the disk, trouble-shoot the system if necessary, and manage its resources.

NOTE: THIS TAPE CONTAINS YOUR ONLY PERMANENT COPY OF THE CURRENT REVISION OF THE LRS-10 MICROCODE.

The Software Support Tape is structured so that the programs on Files 2 through 5 can be loaded and executed directly from the tape. Each is a stand-alone program; this means that they do not need, and cannot have, an operating system running when they are executed. There is also a program (file 7 for AOS/VS, file 8 for AOS) that you will install on your system disk that runs under the operating system.

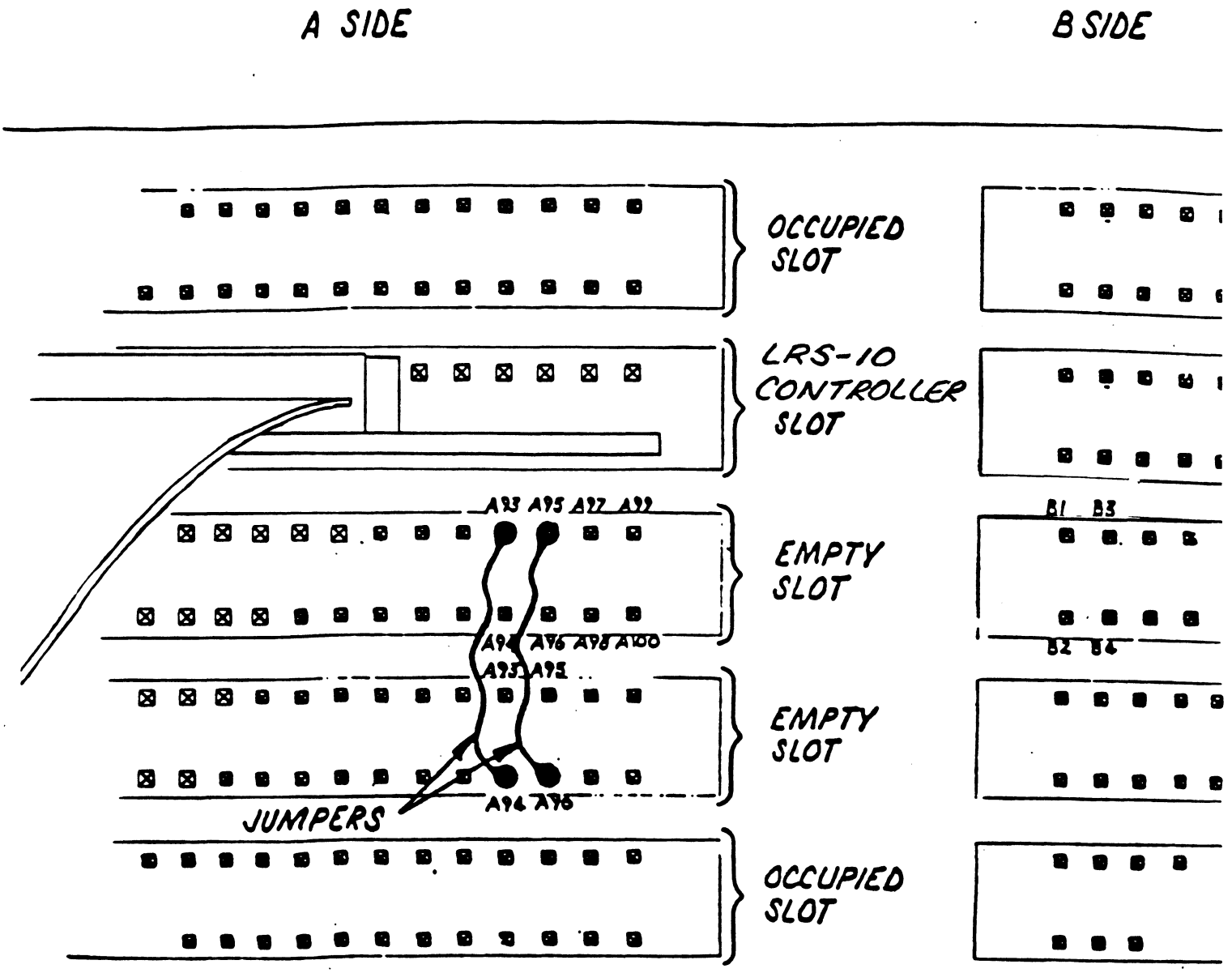
Files 0 and 1 contain the software that enables you to boot from the tape and select the particular program you want to load into the system. The boot procedure is detailed in Section 2.8.

At several points in the installation procedure you will find sample dialogues for the programs. In these samples, the lines that the computer prints will be shown entirely in upper case letters. The sample user responses will be on the next line below, indented. The CARRIAGE RETURN response will be designated by "<cr>". Comments and suggestions, which do not appear in an actual session and are here provided for clarification, will be preceeded and followed by the characters "**".

2.2 SELECT A SLOT FOR THE CONTROLLER

The Controller may be installed in any I/O or I/O-MEM slot. Consult the hardware manuals for your particular computer to identify the appropriate slots.

FIGURE 2.2 Backplane Priority Jumpers



2.2.1 PRIORITY SELECTION

The Controller must receive two priority signals from the DG minicomputer backplane: DCH Priority In (Pin A94), and Interrupt Priority In (Pin A96). If there are vacant slots between the Controller and the processor, or between the Controller and another controller already installed in the chassis, jumper wires must be installed to obtain priority continuity. To "jumper across" unused slots, connect DCH Priority Out (Pin A93) to DCH Priority In (Pin A94) and Interrupt Priority Out (Pin A95) to Interrupt Priority (Pin A96). See Figure 2.2.

2.3 INSTALL THE CONTROLLER

FIRST, BE SURE THE COMPUTER IS TURNED OFF. Pull the lock tabs on the two front corners of the board out as far as they will go. Next, carefully guide the Controller board into the I/O slot you selected in Section 2.2. When the board engages the backplane connectors, gently press the lock tabs in to provide insertion leverage. Use equal pressure on both lock tabs until the board seats firmly into the backplane connectors.

2.3.1 DEVICE CODE SELECTION

The recommended device code for the LRS-10 Controller is 64 (octal). However, any useable device code can be selected, as long as there is not already a controller in the system with that code.

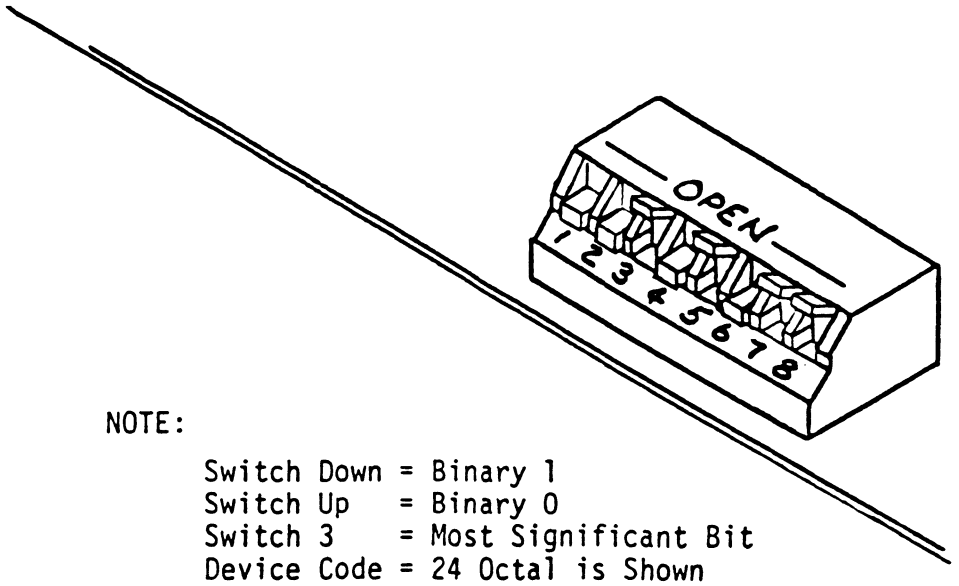
There is a set of switches on the edge of the board that allows you to easily set the device code. Switches 3 through 8 specify device code. Switch 1 is reserved and should be placed in the "Down" position. Refer to Figure 2.1 and 2.3 for switch location and proper selection.

If, at a later date, you wish to change the device code for the Controller, you need not remove the board from the computer chassis. Simply set the switches accordingly and press RESET on the computer. The new device code will then be operative.

2.3.2 EEPROM WRITE DISABLE

Switch position 2 (see Figure 2.3) is used for disabling WRITES to the EEPROMs when in the DOWN position. If EEPROMs are to be re-configured, this switch must be placed in the UP position.

FIGURE 2.3 Device Code and EEPROM Write Disable Switches



NOTE:

Switch Down = Binary 1
Switch Up = Binary 0
Switch 3 = Most Significant Bit
Device Code = 24 Octal is Shown
Switch 2 = **EEPROM Write Disable when Switch is in DOWN Position**

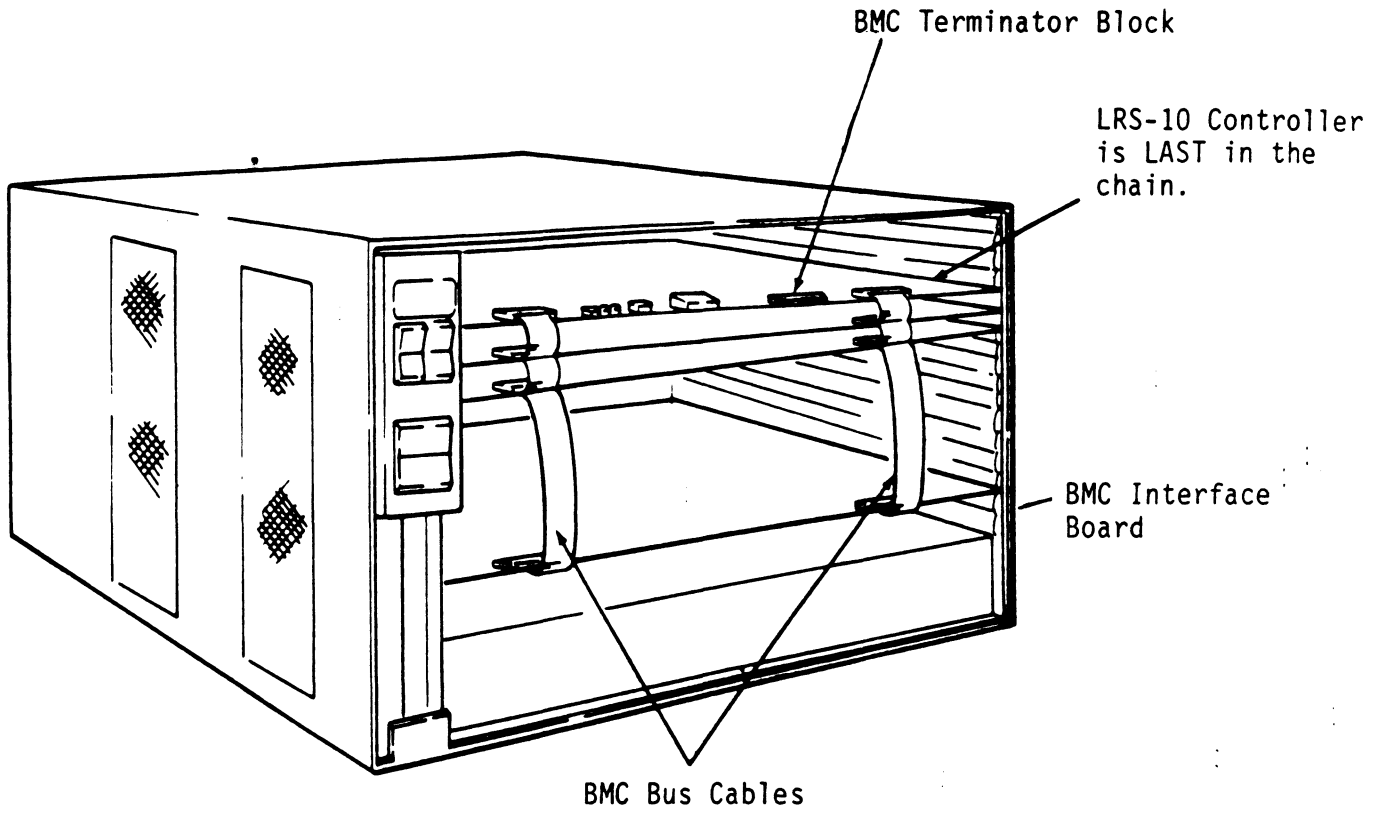
DEVICE CODE	S1 RESERVED	S2 EEPROM Write Disable	S3 DS0	S4 DS1	S5 DS2	S6 DS3	S7 DS4	S8 DS5
0X			UP	UP	UP			
1X			UP	UP	DOWN			
2X			UP	DOWN	UP			
3X			UP	DOWN	DOWN			
4X			DOWN	UP	UP			
5X			DOWN	UP	DOWN			
6X			DOWN	DOWN	UP			
7X			DOWN	DOWN	DOWN			
X0						UP	UP	UP
X1						UP	UP	DOWN
X2						UP	DOWN	UP
X3						UP	DOWN	DOWN
X4						DOWN	UP	UP
X5						DOWN	UP	DOWN
X6						DOWN	DOWN	UP
X7						DOWN	DOWN	DOWN

2.3.3 BMC BUS CABLING AND TERMINATION

The two BMC bus cables daisy-chain from the computer's BMC interface board to the various BMC peripheral controllers, as shown in Figure 2.4. The controller at the end of the chain must have a BMC terminator block installed; the others must not. If the LRS-10 Controller is to be installed as the last (or only) BMC controller, then make sure the terminator block is installed in the appropriate header connector, located as shown in the figure. For another view of this connector, see Figure 2.1. The Controller is shipped from the factory with the terminator block installed.

Install the BMC bus cables as shown in the figure by plugging the single-plug end of the cables into the DG BMC interface board, and the multiple-plug end of the cables into the LRS-10 Controller and other BMC peripheral controllers.

FIGURE 2.4 BMC Bus Cabling



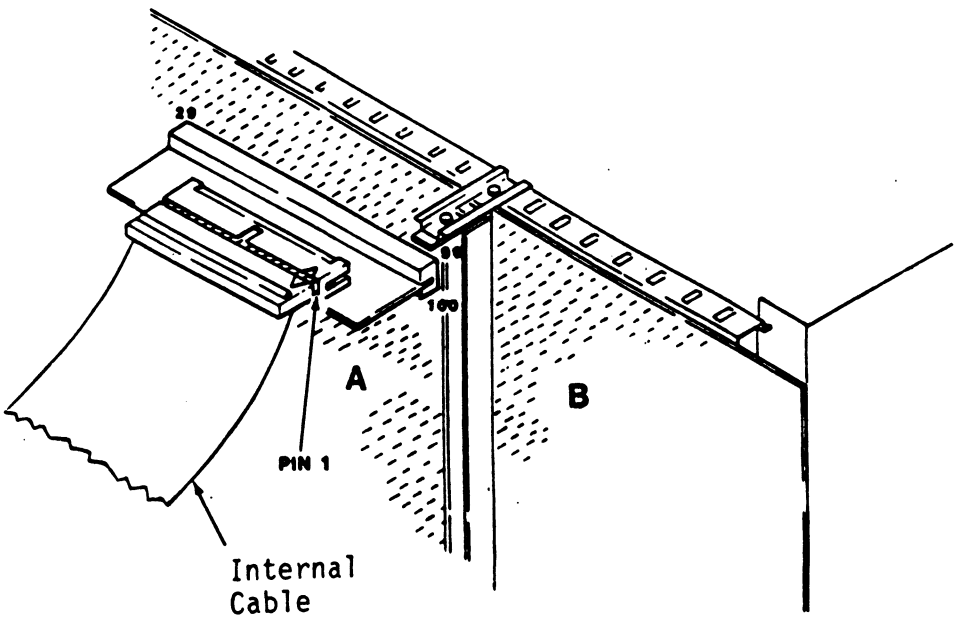
2.4 INSTALL THE PADDLEBOARD

On computers with vertically installed boards, the "A" side can be either the top or the bottom, depending on which way the component sides of the boards are facing. As boards are installed, if the component sides are facing right (as viewed from the front), the "A" side will be the bottom. If the component side is facing left, the "A" side will be on top.

Locate the two rows of pins on the "A" side of the backplane for the slot containing the Controller. Ensure that no pins are bent. Position the "A" paddleboard connector block so that it covers the pins on the right-most end of the rows (pins 29 through 100). Be sure that the header connector on the paddleboard is facing up. Press the connector securely over the pins, making sure all pins insert and do not bend, until the connector block is flush with the backplane. See Figure 2.5.

CAUTION: COMPONENT DAMAGE MAY OCCUR IF THE PADDLEBOARD IS MISALIGNED. MAKE SURE THE BLOCK IS NOT SHIFTED RIGHT OR LEFT. ALSO, MAKE SURE 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.

FIGURE 2.5 Paddleboard and Internal Cable Installation



2.5 INSTALL THE MODULES IN THE CABINET

ZETACO recommends that the LRS-10 modules be installed one directly above the other in the system cabinet, with the Optical Drive Module on the top. You will need approximately nine inches of vertical space for the two modules. You can position the pair anywhere in the cabinet according to the dictates of your present configuration.

2.5.1 OPTICAL DRIVE MODULE INSTALLATION

ZETACO has provided a system of extendable slides for mounting the Optical Drive Module in the system cabinet. There are two slide assemblies; each slide assembly in turn consists of a part that attaches to the vertical mounting rails in the cabinet (the OUTER SLIDE MEMBER), and a part that attaches to the module itself (the INNER SLIDE MEMBER). See Figure 2.6. Also, for each slide assembly there are two L-shaped slotted-hole brackets. Mounting hardware is included.

To mount the module in the cabinet:

1. On each slide assembly, lift up the latch on the front end of the INNER SLIDE MEMBER and fully extend the slide.

2. Attach a front and rear mounting bracket to each of the two OUTER SLIDE MEMBERS, using the hardware provided. At this point, the screws should only be "finger tight."

3. Mount the OUTER SLIDE MEMBERS to the vertical rails on both sides of the cabinet, sliding the mounting brackets forward or backward as necessary to span the distance between the front and rear rails. Leave the screws holding the OUTER SLIDE MEMBERS to the vertical rails "finger tight", but at this time fully tighten the screws attaching the mounting brackets to the OUTER SLIDE MEMBERS.

4. Check the slide assemblies for binding. Pressing on the latch near the center of the INNER SLIDE MEMBERS will allow the slides to retract. Move them in and out several times; they should move freely. Leave them in the fully extended position.

5. Locate the three mounting holes on each INNER SLIDE MEMBER. There are access slots on each intermediate slide member through which you can reach the mounting holes. Have the six screws for these holes WITHIN REACH and ready to install.

NOTE: THE NEXT STEP INVOLVES LIFTING THE UNIT. TWO PEOPLE ARE NEEDED TO FINISH THE INSTALLATION.

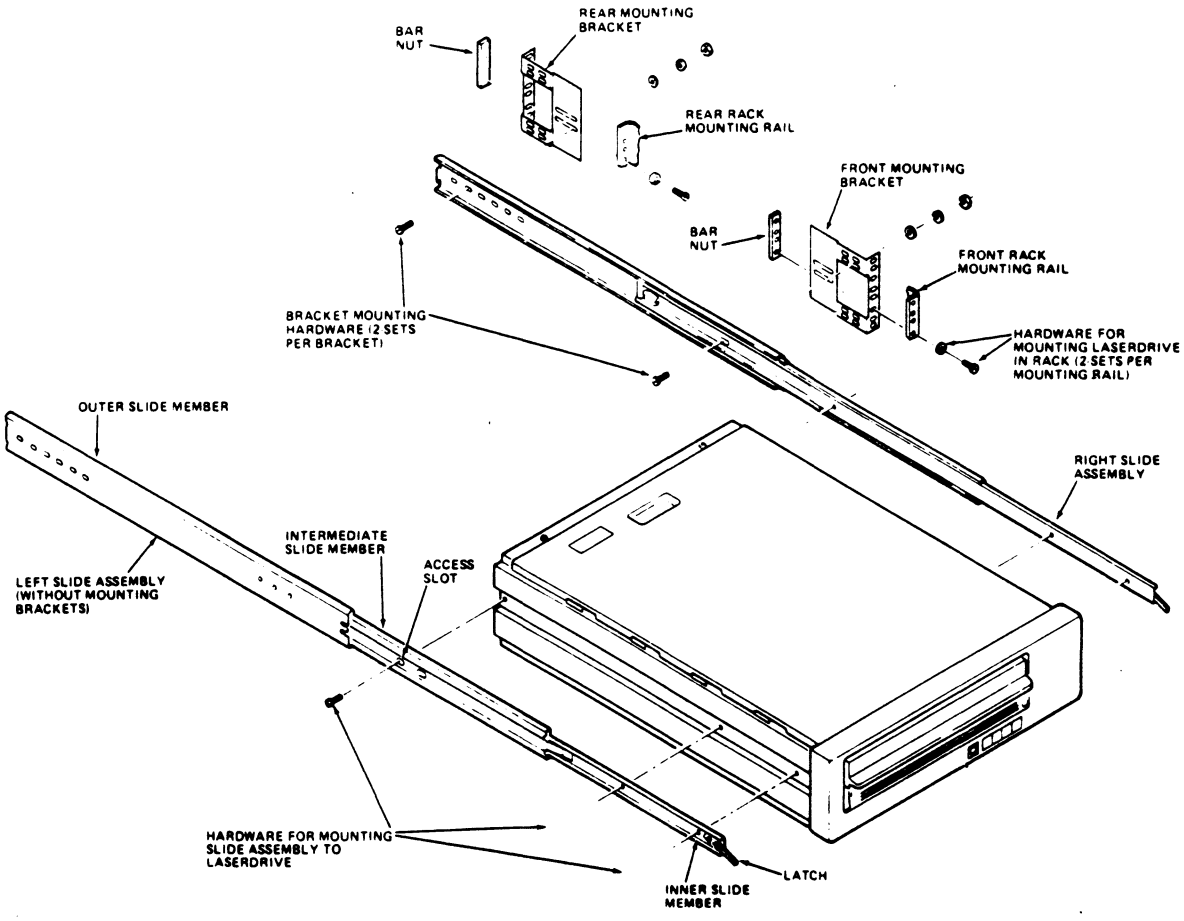
6. Carefully lift the drive between the slide assemblies.

7. WHILE SUPPORTING THE UNIT, install the six screws through the access slots, securing the INNER SLIDE MEMBERS to the unit.

8. Test the ease of travel of the slides by moving the unit back and forth a few times. If all motion is free and easy, slide the module into the cabinet. The installation is now complete.

To extend the module, first lift the latch at the front of each slide assembly. Now that the slides are installed, you must remove the front panel of the drive to do so. See Appendix C, PREVENTIVE MAINTENANCE, for instructions on how to remove the panel.

FIGURE 2.6 Optical Drive Module Slide Assembly



2.5.2 MAGNETIC DISK DRIVE MODULE INSTALLATION

Like the Optical Drive Module, there are two slide assemblies for each Magnetic Disk Drive Module (See Figure 2.7). Again, each slide assembly consists of an OUTER SLIDE MEMBER that attaches to the vertical mounting rails in the cabinet and an INNER SLIDE MEMBER that attaches to the module itself. See Figure 2.7a. For the Magnetic Disk Drive Module, each slide assembly requires one L-shaped slotted-hole bracket for attaching the OUTER SLIDE MEMBER to the rear vertical rails. Again, mounting hardware is included.

The Magnetic Disk Drive Module is shipped from the factory with the slide assemblies attached. To complete the installation of the module:

1. Attach the L-bracket to the rear end of each OUTER SLIDE MEMBER. On the inside of each L-bracket there is a quarter-turn fastener that mates with a receptacle in the rear of the module. Insert this fastener and turn it so that the L-bracket is locked to the module. Then attach the L-bracket to the OUTER SLIDE MEMBER using the supplied hardware. See Figure 2.7b and c. At this point, the screws should only be "finger tight."

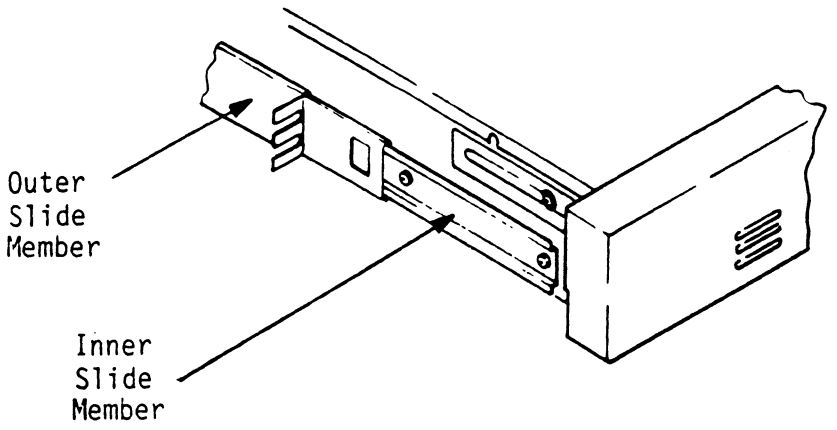
2. Unlock the fasteners at the rear of the module and disconnect the OUTER SLIDE MEMBER from the INNER SLIDE MEMBER of each slide assembly by fully extending the slides and then pressing the release clips.

3. Mount the OUTER SLIDE MEMBERS to the vertical rails on both sides of the cabinet, sliding the L-brackets forward or backward as necessary to span the distance between the front and rear rails. Leave the screws holding the OUTER SLIDE MEMBERS to the vertical rails "finger tight," but at this time fully tighten the screws attaching the L-brackets to the OUTER SLIDE MEMBERS.

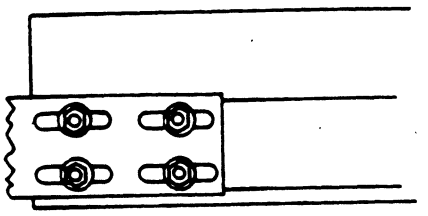
4. Extend the slides of both OUTER SLIDE MEMBERS until they have reached their maximum position. Lift the module and carefully guide the INNER SLIDE MEMBERS into the OUTER SLIDE MEMBERS, adjusting the OUTER SLIDE MEMBERS towards or away from the module as required to obtain accurate alignment. Slowly slide the module into the cabinet a few inches, taking care that the slides travel smoothly. When satisfied, and while CONTINUING TO SUPPORT MOST OF THE WEIGHT OF THE MODULE, fully tighten the OUTER SLIDE MEMBERS to the vertical rails.

5. Slide the module fully into the cabinet and again be sure it travels smoothly. Finally, extend it fully, allowing its full weight to be supported by the slides. If all motion is free and easy, slide the module back into the cabinet and turn the fasteners in the back to lock the unit in place. The installation is now complete.

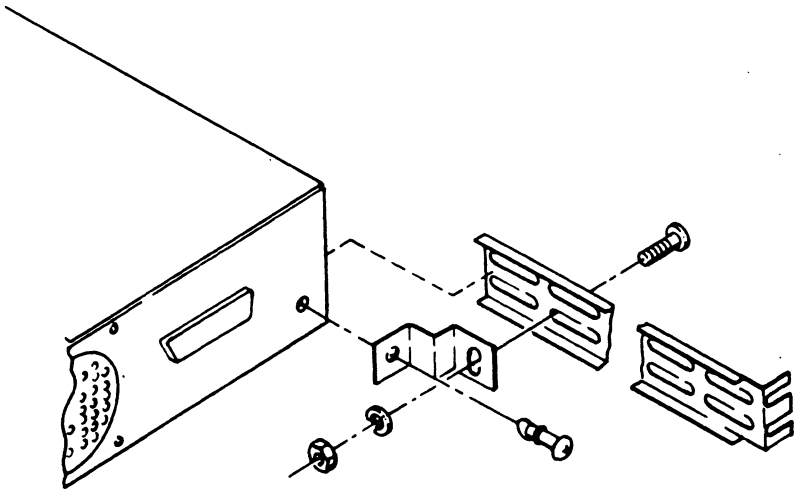
FIGURE 2.7 Magnetic Disk Drive Module Slide Assembly



(a)



(c)



(b)

2.6 CONNECT THE CABLES

The inter-module cabling scheme for the LRS-10 consists of two parts: an internal cable, and a set of external cables.

2.6.1 INTERNAL CABLING

The Internal Cable is a flat 50-conductor cable with a socket connector on one end and a "D" connector on the other. As shown in Figure 2.5, the socket connector plugs into the "A" paddleboard. The other end of this cable (the "D" connector) mounts on the computer bulkhead.

To mount the "D" connector on the bulkhead, first remove the cover from the desired mounting hole, and the hex bolts, washers, and nuts from the connector. Then, insert the connector into the hole in the bulkhead from the inside, insert the hex bolts from the outside, and secure the connector to the bulkhead.

If the computer chassis is not FCC-compliant and therefore has no bulkhead, simply fasten the "D" connectors of the Internal and External cables together.

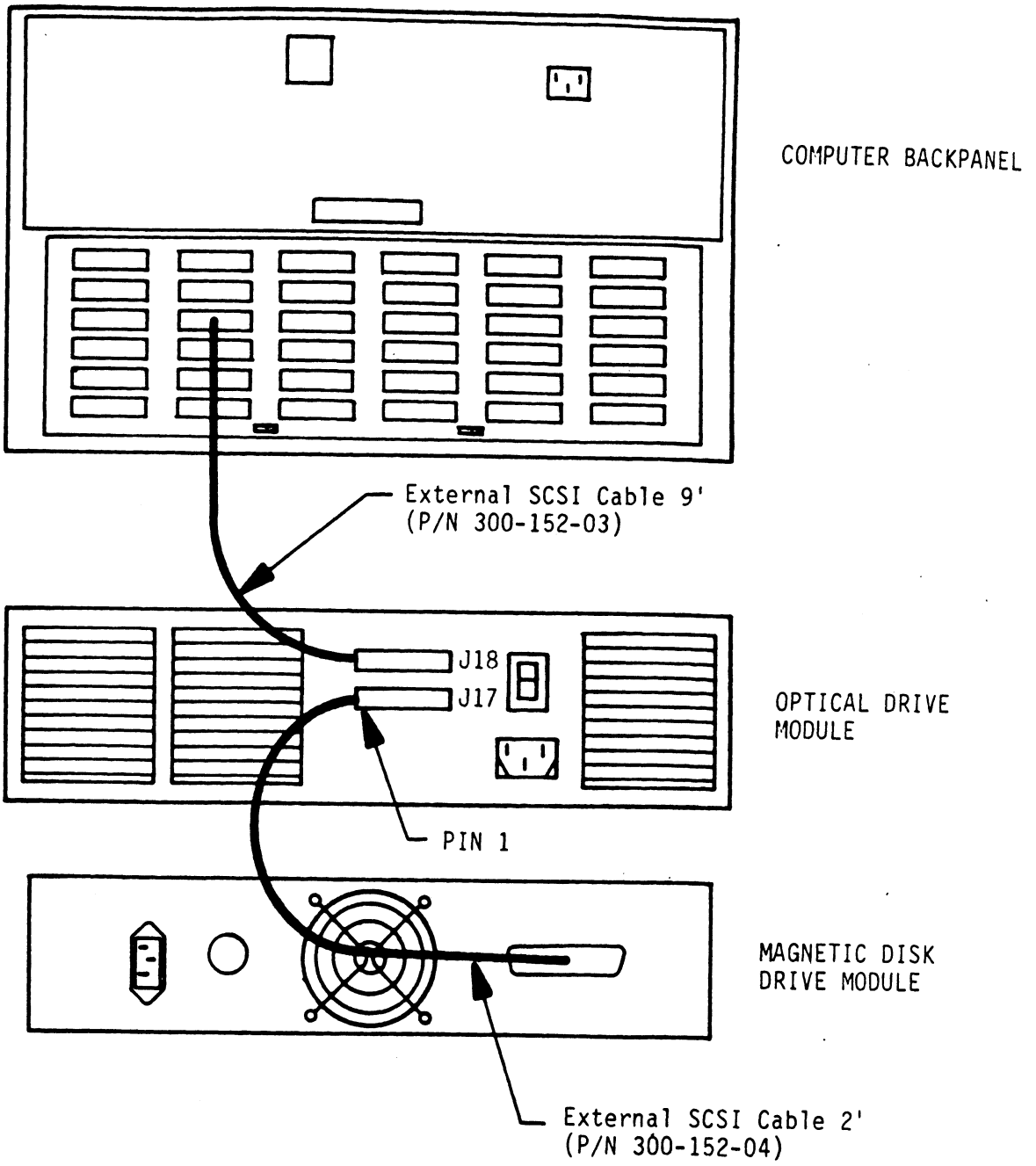
2.6.2 EXTERNAL CABLING

Two external cables, identical except for length, are required to operate the LRS-10 in its basic configuration. These cables, the External SCSI Cables, have at one end a 50-pin 'D' connector and at the other a 50-pin connector block. The 9' cable is connected from the computer bulkhead to the connector labelled "J18" on the rear panel of the Optical Drive Module. The 2' cable is connected from "J17" on the rear panel of the Optical Drive Module to the connector on the rear panel of the Magnetic Disk Drive Module.

Figure 2.8 illustrates this connection scheme. Be sure to observe the orientation of the connector block with respect to the location of pin 1.

If you are installing multiple Optical Drive Modules at this time, see Appendix B for the expanded cabling scheme and additional drive preparations.

FIGURE 2.8 Cabling for LRS-10 with one Optical Drive Module (Rear View)



See page B-3 for cabling of fully populated subsystem.

2.7 POWER UP THE SUBSYSTEM

2.7.1 MAGNETIC DISK DRIVE MODULE OPERATION

Begin the power-up sequence by turning on the Magnetic Disk Drive Module. You will find an ON/OFF rocker switch on the front panel of the module; place it in the ON position. Observe that the indicator light imbedded in the switch and the READY LED in the upper left corner of the front panel both become illuminated, and that the fan in the rear of the unit is turning. Check the cord, fuse and wall receptacle if not.

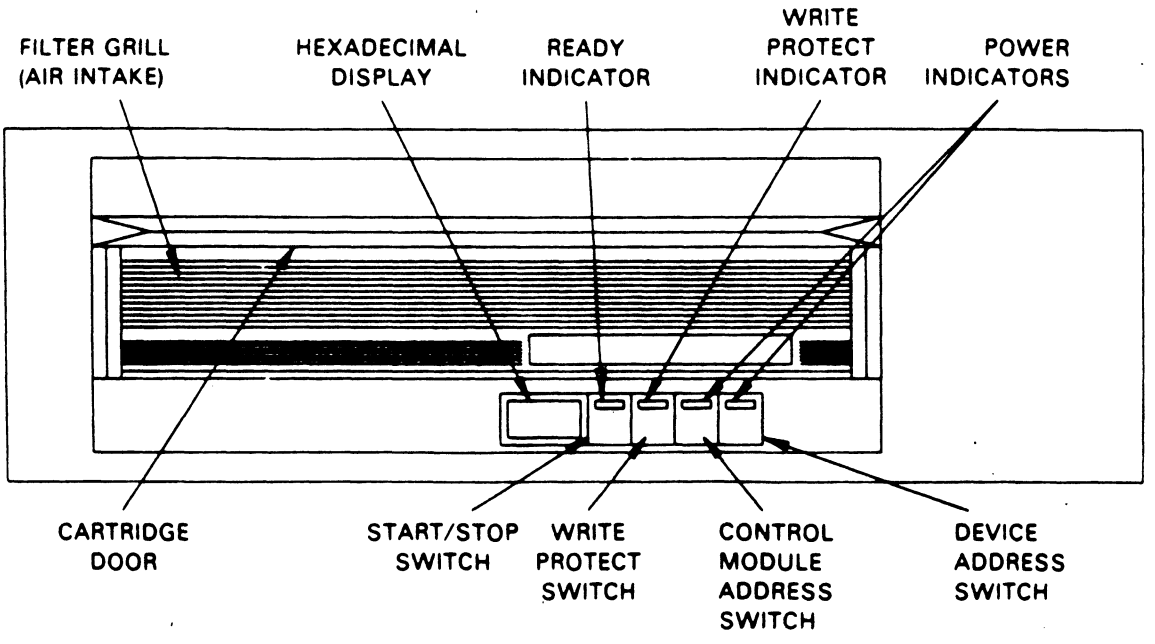
WARNING: DO NOT OPERATE THE UNIT WITH A DEFECTIVE FAN.

The magnetic disk drive should now be spinning. It will take approximately 35 seconds for the disk to reach full rotational speed and become ready. At that time, the READY LED will go out. If it flashes instead, the unit may be defective. Retry the power-up.

2.7.2 OPTICAL DRIVE MODULE OPERATION

Place the ON/OFF rocker switch on the rear panel of the Optical Disk Drive in the ON position. Verify that the two Power indicators on the Operator Panel (see Figure 2.9) become illuminated, and that air is flowing out of the rear panel filter grill. If not, check the power cord and wall receptacle. The Hexadecimal Display should be blank.

FIGURE 2.9 Optical Drive Module Operator Panel



Before spinning-up the Optical Drive Module, you must insert a data cartridge. First, be sure that the START/STOP switch on the front of the drive is in the STOP (OUT) position and the READY LED imbedded in the switch is off. Next open the cartridge door at the front of the drive and insert the data cartridge, with the optical access doors to the rear and facing down. Push it in gently until it snaps into place. Then close the cartridge door by lifting the handle.

Now, press the START/STOP switch to the START (IN) position. Since the unit runs Automatic Self-Tests, it may take approximately 3-4 minutes to reach operational speed and become ready. The READY indicator will flash while the unit spins-up, and remain steadily on when the unit becomes ready. The Hexadecimal Display should be blank after briefly flashing "BB". If anything else is flashed or remains in the display, the drive is bad. If the hexidecimal display shows "FA", try replacing the platter.

2.7.3 COMPUTER POWER-UP

Once your drive modules have been turned on and are ready for operation, you can power-up the computer . After you press the computer's power switch, you will notice that some of the LEDs on the front edge of the LRS-10 Controller will be active. They are indicating the status of the board's automatic self-tests.

At the end of the sequence all LEDs should be off. This indicates that the Controller has successfully passed its self-tests and is ready to receive commands from the system.

If the LED sequence "hangs" with the yellow LED on, you may have forgotten to turn on your drive modules first. If so, turn them on in the manner described above. The Controller is actually waiting for a response from the drives; when the drives become ready, the LEDs will complete their sequence.

2.7.4 CONTROLLER SELF-TEST ON POWER-UP

SELF-TEST checks out 90% of all the internal functions of the Controller once every time power is applied. SELF-TEST is actually composed of three independent modules, each of which is associated with an LED on the front of the board. The LEDs are grouped (three on the left, two on the right) according to which "side" of the board they are reporting on. See Figure 2.1.

SCSI Module	Red LED (Left)
HOST Module	Red LED (Right)
CABLE Module	Yellow LED (Left)

The entire set takes approximately 10 seconds to execute. Once SELF-TEST has passed, all LEDs will go out.

If a failure is detected in either the SCSI or HOST module, one or both red LEDs will flash a repeating numerical series; the number of flashes in the series corresponds to the specific subtest that failed. Tables F.1 and F.2 in Appendix F identify the subtests for the SCSI and HOST modules. If the CABLE Module fails, the yellow LEDs will remain steadily lit.

If the red LEDs remain steadily lit, try reseating the board or using a different slot. If problems develop or errors occur during this process, the off-line RECOVER program may be initiated. This program is a vehicle for examination of the on-board error log. See Section 4.3, TROUBLE-SHOOTING, for more information.

After the drives and boards have been physically cabled, powered-up and have successfully passed SELF-TEST, the following steps can be undertaken to bring the subsystem into operation.

1. Configure the controller.
2. Prepare the Magnetic using off-line Utilities.
3. Run RELI test program to verify installation. All programs necessary are provided on software support tape.
4. Initialize a blank platter.

2.8 BOOT THE SOFTWARE SUPPORT TAPE

The Bootstrap Procedure for the Software Support Tape is:

1. Mount the Software Support Tape on a tape drive and put it on-line. Be sure that the BPI setting matches that specified on the tape label.

2. Execute a "Program Load." The Program Load procedure is different for different computers. Consult the Operator's Manual for your computer to determine the correct one.

3. The Software Support Tape menu will be displayed:

FILE #	PROGRAM
2	LRS CONFIGURATOR
3	LRS OFF-LINE UTILITIES
4	LRS RELIABILITY
5	LRS RECOVER PROGRAM
6	DUMP FILES FOR LRS
7	AOS/VS ON-LINE UTILITY PROGRAM(S)
8	AOS ON-LINE UTILITY PROGRAM(S)

FILE NUMBER?

2

** You should enter the number of the program you wish to execute. At this point in the installation procedure, we entered "2" to load the Configurator program. **

2.9 CONFIGURE THE LRS-10 CONTROLLER

The Configurator program allows you to tailor some of the operating parameters of the Controller to suit your system without having to resort to cumbersome on-board switches or jumpers. The parameters are stored on the Controller in an EEPROM (Electrically Erasable Programmable Read-Only Memory). They are preserved even when power is removed from the board, and are changeable only through the Configurator program.

Once you have given the program the device code of the Controller (the octal number of the switch settings established in Section 2.3.1), the program will return with a request that you enter a command. This prompt indicates that the program has successfully communicated with the Controller at that device code, and the Controller is ready to be configured.

If the program had not returned with this prompt, that would have indicated that the system was unable to contact the Controller at that device code. If such is the case, turn everything off and double-check all of the preceeding installation steps.

Help with all aspects of the program's operation is available on-screen. The "W" command gives an overview of the program's use. The "H" command gives details on some of its operational characteristics. Brief explanations of most of the parameters themselves are available by selecting the parameters from the main menu and entering an "H" instead of the requested values.

Most of the parameters come from the factory preset with recommended values. The ones you will need to establish now are the BMC Bus Priority, Break Count Interval, Throttle Burst Rate, Platter ID, and the number of optical drives in your subsystem. The most efficient way to do this is to select the CHANGE ALL FACTS option from the menu.

To fine-tune the controller, select T, Tuning Features/Platter Segmenting. Two things should be considered; R - Set Read Ahead Enable/Disable and W - Write Direct Enable/Disable. The Read Ahead will reduce the rotational latency time of the optical drive. The Write Direct will put data directly onto the optical platter with the directory going into the cache. This will speed up the Write command.

2.9.1 THE PROGRAM OPTIONS

The following is a complete list of available program options, with comments where they are pertinent.

1. CHANGE ALL FACTS

   This option automatically presents all of the configurable features available in the main menu for modification. These are the Platter ID (#4 below), BMC Priority (#2), Throttle Burst Rate (#6), Break Count (#7), Base Platter Number (#8), number of optical drives connected to the Controller (#5), and the Operating System (#3). After all values have been entered, a List (#11) is run so that you can verify the configuration.

   Note that running this option will automatically set all of the tuning features (see #14 below) to their default states.

   A - ALL FACTS
   B - BMC
   C - OPER SYS
   D - PLATTER IN
   E - # DRIVES
   F - THROTTLE
   G - BREAK COUNT
   P - PLATTER #
   H - HELP
   W - HELP
   L - LIST
   N - START PRINT
   O - STOP PRINT
   T - TUNING
   U - UPDATE
   Q - QUIT

2. BMC PRIORITY

   This value determines the level of BMC bus priority given to this Controller for data transfer. Each controller in the system MUST have a different priority. The controller in the system with the highest priority will be serviced first; the one with the lowest will be serviced last. Usually, the controller communicating with the system disk is assigned the highest priority.

3. OPERATING SYSTEM

This choice allows you to specify whether the operating system under which the LRS-10 will be running will be AOS or AOS/VS, or RDOS.

4. PLATTER ID

The Platter ID is a user-selected alphanumeric name, with a maximum length of 32 characters. It is intended as an aid in helping you to organize your data. For example, the records for School District 5 might be on a platter designated "DISTRICT 5", or on several platters with the same ID. If you do not wish to assign a specific Platter ID, simply press "New Line" to select the default "empty" value.

5. NUMBER OF OPTICAL DRIVES

The number of optical drives can be any number between one and four. We recommend that you enter the maximum number. This will allow you to add more drives later without having to change this configuration parameter each time you do so.

6. THROTTLE BURST RATE

This term describes the number of words transferred to/from system memory to the Controller on each bus access. If the value is set too low, subsystem performance may be slow. If it is set too high, you may see "data late" errors reported from other peripherals on the system. The recommended value is 16.

7. BREAK COUNT

The Break Count interval is defined as the period of time that the LRS-10 Controller is off the BMC bus. This period is a multiple of the BMC Sync Clock period, which in turn varies from computer to computer. A Break Count Interval setting of 0 is equal to one Sync Clock period.. The maximum setting is 256. A setting of 4 is recommended.

If there are other BMC devices present, it may be desirable to increase this count to allow more time for the other devices to access the bus. If the Break Count is set too large, slow disk performance may result. A larger Break Count also allows the CPU more memory time.

8. MODIFY BASE PLATTER NUMBER

Each active platter is automatically assigned a unique number by the Controller. When the magnetic disk is formatted, it is initialized to the configured Base Platter Number, and active platter numbers increment from this value. If you need to reformat the magnetic disk, but wish to continue numbering platters sequentially, you should first run the Configurator and set the Base Platter Number to the number of the last completed platter. Then reformat the magnetic disk.

9. HELP - OPERATIONS

This option provides on-screen help with operational details of the program such as default entries, exiting from a question, how to get help with a specific question, and how the EEPROM (Electrically Erasable Programmable Read-Only Memory) works.

10. HELP - WHAT TO DO

This option briefly illustrates a sample session with the Configurator program.

11. LIST ALL CONFIGURATION FACTS

This selection presents on-screen information about the optical drives in the system, and shows the configured values of the BMC Priority, Platter ID, Base Platter Number, Throttle Burst Rate, Break Count, and the Operating System. Once you are satisfied with your configuration, print a hard copy (see below) and retain it for future reference.

12. START LOGGING TO PRINTER

This option sends information on the screen to the system printer. The printer must be on-line and ready to receive data.

13. STOP LOGGING TO PRINTER

This option stops sending information to the printer.

14. TUNING FEATURES/PLATTER SEGMENTING

This option provides access to a "sub-menu" containing an additional set of configurable features. These features are explained below.

```
I - SET SCRUB SPACE TO 50%
J - SET SCRUB SPACE TO 80%
K - SET SCRUB SPACE TO MAX
L - LIST TUNING FACTORS
S - SEGMENT THE PLATTER (10 SEGMENTS)
M - MOVE TO A NEW SEGMENT ON PLATTER
N - RESET PLATTER FOR NO SEGMENTING
R - SET READ AHEAD ENABLE/DISABLE
W - WRITE DIRECT ENABLE/DISABLE
```

```
-- I - SET SCRUB SPACE TO 50%
-- J - SET SCRUB SPACE TO 80%
-- K - SET SCRUB SPACE TO MAX
```

Three settings are provided in case a platter is extremely bad or a usage mistake has occurred causing excessive scrubs. By starting at "set to 50%", when the space is half full, the subsystem sets an error condition that notifies the user that space is dwindling. The user can then set the scrub space to 80% or MAX and still initiate a purge to save all the data from magnetic onto optical.

-- L - LIST "TUNING" FACTORS

This command displays the current states of the Segment, Read Ahead, Write Direct and Scrub Space features. It also reports the current segment (if the platter has been segmented).

To return to the main menu, simply respond to the command prompt with a carriage return.

-- S - SEGMENT THE PLATTER (10 SEGMENTS)

This command permanently divides a platter into 10 "virtual platters." It is intended for testing and evaluation purposes only. The default state for this feature is "No."

WARNING: INDISCRIMINATE USE OF THIS COMMAND WILL RESULT IN UNUSABLE PLATTERS. NOTE THAT THE COMMAND WORKS IN A "TOGGLE" FASHION; TO SELECT IT FROM THE MENU IS TO EXECUTE IT.

Once you have changed the state of this feature to "YES", the only way to change it back to "NO" is to select "N" in this menu or return to the main menu and select the "CHANGE ALL FACTS" option.

-- M - MOVE TO A NEW SEGMENT ON PLATTER

This command enables you to shift your "working" segment to any of the 10 segments. The default value is the current segment plus one.

-- N - RESET PLATTER FOR NO SEGMENTING

This command will disable and turn off the platter segmenting set-up.

-- R - SET READ AHEAD ENABLE/DISABLE

When Read Ahead is enabled, the Controller actually reads more sectors than requested by the host in the current read command, and temporarily saves them. This is done on the assumption that the NEXT read command will request the next contiguous block of sectors. If the assumption proves to be true, the block of sectors is immediately available in disk memory, eliminating an additional disk rotational latency. If the assumption proves to be false, the saved sectors are abandoned.

The default state for this feature is enabled.

-- W - WRITE DIRECT ENABLE/DISABLE

When Write Direct is enabled, the caching scheme is temporarily bypassed, and data can be written directly onto the optical platter; the bit map and directory will go into the cache.

The default state for this feature is enabled.

15. UPDATE EEPROM

This command stores the configuration information in the EEPROM on the Controller. You must execute it before you exit from the program in order to preserve your configured values.

16. QUIT THE PROGRAM

This option provides for an orderly termination of the program. If you have changed the configuration but forgotten to update the EEPROM, you will be reminded to do so at this point. You will also be reminded that you must press the RESET switch on the computer Operator Panel in order to actually re-initialize the Controller with the new configuration.

2.10 PREPARE THE MAGNETIC DISK DRIVE USING THE OFF-LINE UTILITIES

The data cartridges for the Optical Drive Module require no special preparation before they are used, but you will need to format the media in the magnetic disk drive.

To do so, boot the Software Support Tape and load file #3, the Off-Line Utility program. We will first use the "I" option (INQUIRY THE DRIVE) to verify that we can communicate with the magnetic disk drive. Then we will select the "A" option (DO ALL) to load the Controller's operating microcode onto the board from the tape, format the magnetic disk drive, and install the microcode onto it.

CAUTION: INSTALLATION OF THE MICROCODE ONTO THE MAGNETIC DISK DRIVE IS ESSENTIAL TO PROPER OPERATION OF THE SUBSYSTEM. DO NOT CHOOSE THE "B" OPTION (FORMAT MAGNETIC DISK) ALONE AT THIS TIME. SEE APPENDIX A, UTILITY PROGRAMS, FOR A DISCUSSION OF THE OTHER PROGRAM OPTIONS.

Use the sample dialogue below to guide you.

```
LRSU - UTILITY FUNCTIONS FOR OPTICAL STORAGE SUBSYSTEM
                    REV. LEVEL = X.XX
                    PRODUCT OF ZETACO

 THIS PROGRAM CONTAINS THE UTILITY FUNCTIONS FOR AN LRS
 OPTICAL SUBSYSTEM.  FOR AOS AND AOS/VS IT REPLACES FORMATTING
 BUT NOT DFMTR.

 ENTER C TO CONTINUE:
      C
```

```
AVAILABLE FUNCTIONS ARE:

A - DO ALL:  FORMAT, INSTALL FIRMWARE
B - FORMAT MAGNETIC DISK
C - INSTALL ARZ FIRMWARE ON MAGNETIC DISK
D - INSTALL SCSI FIRMWARE ON MAGNETIC DISK
I - INQUIRY THE DRIVE
R - (RE)INITIALIZE CONTROLLER
P - PLATTER COMPLETION (PURGE OF MAGNETIC)
J - SET MAGNETIC KEY TO ACTIVE
K - SET THE MAGNETIC KEY TO EMPTY
H - HELP
L - LOGGING TO PRINTER
Q - QUIT
CHOICE?

     I

ENTER DEVICE CODE FOR DISK CONTROLLER [64]

     <cr>
```

** The characters in brackets are the default response. To enter the default response we pressed <cr>. If our Controller had been at another device code, we would have entered that number instead. **

```
--CONTROLLER INIT ROUTINE
--INQUIRY COMMAND
ENTER UNIT NUMBER:

     3

- VENDOR ID IS CDC
- PRODUCT ID IS 94161-XXX
- PRODUCT REVISION LEVEL IS XXX
ENTER C TO CONTINUE:
```

** This response indicates successful communication with the magnetic disk drive. Note that a product revision level may or may not be given. If you receive any other response, TURN EVERYTHING OFF and review all of the preceeding installation steps. Since in our sample we received the correct response, we now enter a "C" to go on to the DO ALL option. **

```
     C
```

```
AVAILABLE FUNCTIONS ARE:

A - DO ALL:  FORMAT, INSTALL FIRMWARE
B - FORMAT MAGNETIC DISK
C - INSTALL ARZ FIRMWARE ON MAGNETIC DISK
D - INSTALL SCSI FIRMWARE ON MAGNETIC DISK
I - INQUIRY THE DRIVE
R - (RE)INITIALIZE CONTROLLER
P - PLATTER COMPLETION (PURGE OF MAGNETIC)
J - SET MAGNETIC KEY TO ACTIVE
K - SET MAGNETIC KEY TO EMPTY
H - HELP
L - LOGGING TO PRINTER
Q - QUIT

CHOICE?

     A

THIS FUNCTION WILL ERASE THE DATA CURRENTLY ON THE MAGNETIC
DISK.  YOU SHOULD ONLY RUN IT IF YOU DO NOT HAVE AN ACTIVE
PLATTER ASSOCIATED WITH THE MAGNETIC DISK.  ANY PLATTERS
WHICH HAVE BEEN "COMPLETED" ARE NOT ACTIVE.

**  See Section 3, USER GUIDELINES, for an explanation of
"active" and "completed" platters.  **

ENTER Y IF YOU WISH TO PROCEED WITH THIS FUNCTION.
     Y

-- INQUIRY COMMAND
-- FORMATTING
-- INSTALLING ARZ FIRMWARE
-- INSTALLING SCSI FIRMWARE
-- ALL FUNCTIONS COMPLETE

ENTER C TO CONTINUE:

**  The entire series of operations will take approximately
15 minutes to complete.  You can verify that the program is
indeed operating by observing the LEDs on the front of the
Controller; the right-most green LED (Host Busy) should be
on.  To exit from the program at this point, enter a "C" and
select the "Q" (QUIT) option from the menu.  **
```

```
AVAILABLE FUNCTIONS ARE:

A - DO ALL:  FORMAT, INSTALL FIRMWARE
B - FORMAT MAGNETIC DISK
C - INSTALL ARZ FIRMWARE ON MAGNETIC DISK
D - INSTALL SCSI FIRMWARE ON MAGNETIC DISK
I - INQUIRY THE DRIVE
R - (RE)INITIALIZE CONTROLLER
P - PLATTER COMPLETION (PURGE OF MAGNETIC)
J - SET MAGNETIC KEY TO ACTIVE
K - SET MAGNETIC KEY TO EMPTY
H - HELP
L - LOGGING TO PRINTER
Q - QUIT

CHOICE?

     Q

YOUR MAGNETIC DISK HAS BEEN INITIALIZED AND SHOULD NOT NEED TO
BE INITIALIZED AGAIN, EXCEPT IN SPECIAL CIRCUMSTANCES.  SOME
CIRCUMSTANCES MIGHT BE:
     -   INSTALLING A NEW MAGNETIC DISK IN THE SUBSYSTEM.
     -   IF THE FORMAT OR SUBSYSTEM DATA ON THE MAGNETIC IS
         LOST.
     -   TO UPDATE THE MAGNETIC DISK WITH A NEW REVISION OF
         FIRMWARE.
ALL OPTICAL PLATTERS ARE PREFORMATTED WHEN SHIPPED.  WHENEVER A
NEW PLATTER IS USED IN YOUR SYSTEM, YOU MUST RUN DFMTR ON EACH
NEW OPTICAL PLATTER.

**YOU MUST SPECIFY THAT NO PATTERNS ARE TO BE RUN IN DFMTR.**
**THE OPTICAL STORAGE SUBSYSTEM IS A WRITE-ONCE MEDIUM.**

The magnetic disk drive is now prepared for operation.

For more detail on how to use the off-line Utilities, see
Appendix A.
```

2.11 VERIFY THE INSTALLATION USING RELIABILITY TEST PROGRAM

The best way to verify that the LRS-10 has been successfully installed is to run the Reliability program on the subsystem for 30 minutes or more. While this is not required to begin full operation, we strongly recommend it, since it is preferable to identify and trouble-shoot problems before going fully on-line.

If you choose not to run the program at this time, go on to Section 2.12.

The Reliability program requires that CPU microcode (for MV-family computers) be already resident in the CPU. If you have an MV computer and have not previously loaded the microcode, you must do so now.

To run the Reliability program, boot the Software Support Tape and load file #4.

CAUTION: MAKE SURE THE OPTICAL DRIVE IS WRITE-PROTECTED AT THIS TIME, SINCE YOU DO NOT INTEND TO PERFORM ANY WRITE TESTING ON IT. DO THIS BY PRESSING THE SWITCH ON THE OPERATOR PANEL LABELED WRITE PROTECT TO THE "ENABLED" (IN) POSITION. SEE APPENDIX E FOR ADDITIONAL INFORMATION ON WRITE PROTECTION.

Although the Reliability program provides a number of options for exercising the subsystem, at this point you can take a simple path through the program questions in order to run basic tests. Use the sample dialogue below to guide you.

For a more detailed explanation of the Reliability program, see Appendix A.

```
ENABLE MAPPING (YES,[NO]);

     <cr>

EXECUTION MODE:
     [R]ANDOM RELIABILITY [S]EQUENTIAL RELIABILITY
ENTER YOUR CHOICE [R]:

     <cr>
```

THIS CONTROLLER CAN BE RUN IN ONE OF TWO MODES. THE FIRST IS RUNTIME MODE. IN THIS MODE THE CACHEING SCHEME IS USED AND THE MAGNETIC DRIVE CANNOT BE ACCESSED DIRECTLY. ALSO, THE MICROCODE WILL BE READ FROM THE DISK SO IT MUST HAVE BEEN INSTALLED ON THE DISK PREVIOUSLY.

THE SECOND MODE IS THE MAINTENANCE MODE. IN THIS MODE THE CACHEING SCHEME IS NOT USED AND THE MAGNETIC CAN BE ACCESSED DIRECTLY. ALSO, THE MICROCODE MUST HAVE ALREADY BEEN DOWNLOADED ONTO THE CONTROLLER BY RUNNING THE "R" SELECTION IN THE UTILITY PROGRAM.

SHOULD THE CONTROLLER BE RUN IN THE RUNTIME MODE (YES,[NO]):

<cr>

LRS-10 RELIABILITY UTILITY
REV. X.XX

COMMAND LIST

[E]NTER A DEVICE	[D]ELETE A DEVICE
[S]TART A PROGRAM	[H]ALT A DEVICE
[R]ESTART THE PROGRAM	[L]IST ERROR TOTALS
[C]OMMAND LIST	[P]RINTER CONTROL
[Q]UIT	[M]ODIFY DISPLAY MODE

ENTER A COMMAND SELECTION:

E

** This command allows you to enter into the program's "memory" information about the device or devices you want to run.

ENTER THE DEVICE CODE [64] (OCT):

<cr>

** In this case, the program is telling you that it requires that your response be in octal. For this sample, we chose the default device code of 64. **

START INITIALIZATION OF CONTROLLER.

END INITIALIZATION OF CONTROLLER.
UNIT 0000 IS READY; SELECT (YES,[NO]):

<cr>

** In Maintenance Mode (which you are now in) the program identifies the Optical Drive Module as Unit 0. We will not test it now.**

```
UNIT   0001   IS READY; SELECT (YES,[NO]):

     <cr>

UNIT   0002   IS READY; SELECT (YES,[NO]):

     <cr>

UNIT   0003   IS READY; SELECT (YES,[NO]):

     yes

THE SELECTED DISK IS THE MAGNETIC DISK.  YOU MAY WRITE AND READ
TO THIS DISK, BUT IF YOU REDUCE THE LOWER BLOCK LIMIT YOU WILL
LOSE DATA THAT IS ON THIS DISK IF IT IS "ACTIVE" OR NOT
"COMPLETE".

THE MINIMUM LOGICAL DISK BLOCK IS [400642] (OCT):

     <cr>

** The default value is the start of an area on the disk
designated as a maintenance area.  Logical blocks below this
point are used in Runtime Mode for current data.  See Section
4.4, TESTING A DISK WITH DATA ON IT, for a broader discussion of
the maintenance area. **

THE MAXIMUM LOGICAL DISK BLOCK IS [456437] (OCT):

     <cr>

WRITE ONLY (YES,[NO]):

     <cr>

READ ONLY (YES,[NO]):

     <cr>

VERIFY DATA ([YES],NO):

     <cr>

DATA TYPES
0-LOGICAL BLOCK ADDRESS        1-FLOATING ZERO
2-FLOATING ONE                 3-ALTERNATE ZEROES (52525)
4-ALTERNATE ONES (125252)      5-ALL ZEROS
6-ALL ONES                     7-RANDOM (ONLY IN RANDOM RELI)
8-ROTATING (125252)            9-RUN ALL PATTERNS
SELECT DATA TYPE [0.] (DEC):

     9
```

** This choice will allow us to thoroughly test the unit by automatically running all of the available data patterns. **

```
                LRS-10 RELIABILITY UTILITY
                        REV. X.XX

                        COMMAND LIST

[E]NTER A DEVICE                    [D]ELETE A DEVICE
[S]TART A PROGRAM                   [H]ALT A DEVICE
[R]ESTART THE PROGRAM               [L]IST ERROR TOTALS
[C]OMMAND LIST                      [P]RINTER CONTROL
[Q]UIT                              [M]ODIFY DISPLAY MODE

ENTER A COMMAND SELECTION:

     S
START ALL ENTERED DEVICES ([YES],NO):

     <cr>
```

** When the test is running, the green LEDs on the front of the Controller will be flashing in random patterns. The READY LED on the front panel of the Magnetic Disk Drive Module may also glow faintly or appear to pulse. **

```
                LRS-10 RELIABILITY UTILITY
                        REV. X.XX

                        COMMAND LIST

[E]NTER A DEVICE                    [D]ELETE A DEVICE
[S]TART A PROGRAM                   [H]ALT A DEVICE
[R]ESTART THE PROGRAM               [L]IST ERROR TOTALS
[C]OMMAND LIST                      [P]RINTER CONTROL
[Q]UIT                              [M]ODIFY DISPLAY MODE

ENTER A COMMAND SELECTION:

     L

STATUS LIST: RUN TIME xx. HRS    xx. MINS.
DEVICE CODE 24 UNIT NUMBER03 MAPPING NOT ENABLED STATE:ACTIVE
MODES: MAINTENANCE, RANDOM, READ/WRITE, DATA CHECK-DO ALL
PATTERNS
BLOCKS WT    xx  BLOCKS RD    xx    TOTAL ERRORS          x

ENTER A COMMAND SELECTION:
```

** At any time while the program is running you can request a list of errors that may have been logged. **
To stop the test, select the "H" command. If you wish to obtain a hard copy of the error log, select the "P" command, and then the "L" command.

2.12 INITIALIZE A BLANK PLATTER USING RELIABILITY

The next step to perform before going ON-LINE is to force initialization of the first platter to be used under the system. Subsequent platters will be initialized automatically following the normal completion of a filled platter. Performing the following steps will help to insure that no errors will occur when running DFMTR.

Insert the blank platter into the optical drive and spin it up. Be sure the platter is not WRITE-protected (see Appendix E) and that the drive WRITE-PROTECT switch is not in use.

Bring up the Reliability program.

```
ENABLE MAPPING (YES,[NO]):

     <cr>

EXECUTION MODE:
     [R]ANDOM RELIABILITY  [S]EQUENTIAL RELIABILITY
ENTER YOUR CHOICE [R]:

     <cr>

     THIS CONTROLLER CAN BE RUN IN ONE OF TWO MODES.  THE FIRST
IS RUNTIME MODE.  IN THIS MODE THE CACHING SCHEME IS USED AND
THE MAGNETIC DRIVE CANNOT BE ACCESSED DIRECTLY.  ALSO, THE
MICROCODE WILL BE READ FROM THE DISK SO IT MUST HAVE BEEN
INSTALLED ON THE DISK PREVIOUSLY.

     THE SECOND MODE IS THE MAINTENANCE MODE.  IN THIS MODE THE
CACHING SCHEME IS NOT USED AND THE MAGNETIC CAN BE ACCESSED
DIRECTLY.  ALSO, THE MICROCODE MUST HAVE ALREADY BEEN
DOWN-LOADED ONTO THE CONTROLLER BY RUNNING THE "R" SELECTION IN
THE UTILITY PROGRAM.

SHOULD THE CONTROLLER BE RUN IN THE RUNTIME MODE (YES,[NO]):

     YES
```

** Going into RUNTIME MODE forces the controller to look for valid cache tables and keys. In the absence of these, recognizing a blank platter, the controller will begin initialization. **

```
                LRS-10 RELIABILITY UTILITY
                       REV. X.XX

                     COMMAND LIST

[E]NTER A DEVICE                [D]ELETE A DEVICE
[S]TART A PROGRAM               [H]ALT A DEVICE
[R]ESTART THE PROGRAM           [L]IST ERROR TOTALS
[C]OMMAND LIST                  [P]RINTER CONTROL
[Q]UIT                          [M]ODIFY DISPLAY MODE

ENTER A COMMAND SELECTION:

     E

ENTER THE DEVICE CODE [64] (OCT):

     <cr>
```

** At this point you should see some activity on the magnetic LED and optical HEX display. **

```
START INITIALIZATION OF CONTROLLER.

END INITIALIZATION OF CONTROLLER.
UNIT   0000   IS READY; SELECT (YES,[NO]):

     <cr>
```

** Do not select Unit 0 here. We do not intend to RUN any tests. If Unit 0 comes ready at this point, the blank platter has been successfully initialized, is now logically mated to the magnetic and ready for data. **

If the Unit 0 messages says it is not ready, the subsystem has a problem to be diagnosed via the RECOVER program error log interpretation. See Section 4.3.

If you encounter errors while running the program, turn to Appendix A for details on the Reliability program. If not, installation is now complete and you are ready to bring the LRS-10 on-line. Before doing so, however, you may wish to do one other thing: Create a Maintenance Platter.

A Maintenance Platter is an optical platter designated for running tests on the Optical Drive. Creating one will allow you to verify the functionality of the optical drive before going on-line, and you will have one ready when and if you need to use it for trouble-shooting.

The creation of the Maintenance Platter is covered in detail in Appendix G.

2.13 "GEN" IN THE NEW DEVICE

Before going on-line, you must introduce the new device into your operating system configuration. To do this, start up your operating system and run the AOSGEN program (or VSGEN for AOS/VS). Specify the device name as "DPJx", where x is the number of the device. At the device code of 64 recommended in Section 2.3.1, this number can be 10 (for Unit 0 at that device code) through 13 (for Unit 3 at that device code).

If you need assistance running the GEN programs, consult your system management documentation.

2.14 RUN DFMTR ON THE SUBSYSTEM

Before running the DFMTR program, be sure that the optical platter is write-enabled. The WRITE PROTECT switch on the Optical Drive Module Operator Panel must be OUT, and the Write Protect Tab on the Data Cartridge must be in the "Write" position. See Appendix E.

WARNING: WHEN YOU RUN DFMTR, THE PROGRAM WILL ASK YOU WHETHER YOU WANT TO DO A SURFACE ANALYSIS. YOU MUST ANSWER NO TO THIS QUESTION OR YOU WILL DESTROY YOUR OPTICAL PLATTER.

In the future, each time you begin a new optical platter you will need to run DFMTR on that platter.

Make note of the LOGICAL DISK NAME that you assign when you run the program, as you will need to specify it when you MOUNT your platter in Section 2.15. If you need help with the DFMTR program, consult your DG system management documentation.

2.15 STORE THE SOFTWARE SUPPORT PROGRAMS ON YOUR SYSTEM DISK

To store all needed programs from your support tape onto a system disk you will need to load two files from the tape. The first is File 6. The second is either File 7 for AOS/VS or File 8 for AOS.

To load the files, use the standard CLI commands for loading from tape:

For AOS and AOS/VS, working from root (:):

```
SUPERU ON
CREATE/DIR LRS
DIR LRS
LOAD/V/R @MTzx:y, where:
```

z is the type of mag tape controller (A,B,C,D, OR J);
x is the unit number;
y is the number of the file on the tape.

REMINDER: YOU MUST LOAD FILE 6 FROM THE SUPPORT TAPE IN ADDITION TO EITHER FILE 7 OR 8 TO HAVE ALL PROGRAMS LOADED ONTO YOUR SYSTEM DISK. ALTHOUGH YOU NOW HAVE YOUR UTILITY PROGRAMS SAVED ON DISK, IT IS IMPORTANT TO RETAIN THE SOFTWARE SUPPORT TAPE. IT CONTAINS YOUR ONLY COPY OF THE CURRENT REVISION OF THE CONTROLLER MICROCODE. Programs may now be loaded in 2 ways.

2.15.1 LOADING THE PROGRAMS FROM SYSTEM DISK

Do a "Program Load" to your system disk. This procedure differs for the various DG computers; if you are unsure of the procedure for your system, consult your DG system documentation.

When the system prompts for a system pathname, enter:

```
:LRS:<program name>
```

The program names are:

```
CFLRS.SV     -- Configurator
LRSU.SV      -- Off-Line Utilities
LRSR.SV      -- Reliability Utility
SALRSREC.SV  -- Recover Program
```

2.15.2 LOADING THE PROGRAMS FROM THE SOFTWARE SUPPORT TAPE

1. Mount the Software Support Tape on a tape drive and put the drive on-line. Be sure that the BPI setting matches that specified on the tape label.

2. Execute a "Program Load". The Program Load procedure is different for different computers. Consult the Operator's Manual for your computer to determine the correct one.

3. The Software Support Tape menu will be displayed. You should enter the number of the program you wish to execute.

2.16 MOUNT A PLATTER

The final step in bringing your LRS-10 on-line is "mounting" the platter. This means introducing the platter into the system as the logical disk unit you created by running DFMTR in Section 2.14. The method described here uses the On-Line Subsystem Utility MOUNT operation. For more information on the mounting concept, see Section 3, USAGE GUIDELINES.

The On-Line Subsystem Utility program runs only under the operating system. You loaded it onto your system disk in Section 2.15 above. To run the program, "DIR" to ":" and type:

```
LRS:LRS
```

Select the MOUNT option from the menu. The program will ask you to specify your drive and platter. Your drive is the DPJx device that you "gen'd in" in Section 2.13. The platter is equivalent to the LOGICAL DISK NAME you assigned when you ran DFMTR in Section 2.14.

When you have answered these questions, the program will return with a report on the current usage of your platter and a message that the MOUNT operation succeeded. At this point, your LRS-10 is fully on-line and ready to receive data.

3.0 USAGE GUIDELINES

Since the LRS-10 employs Write-Once media, usage of the subsystem must be carefully considered beforehand. Although the SCRUB/APPEND feature of the LRS-10 allows a certain number of rewrites without affecting subsystem function, the rewrite area is limited and could eventually be filled if rewrites occur indiscriminately.

The most obvious use for Write-Once media is for archival. Such applications as CAD/CAM drawings, libraries, medical records or scans and judicial documents, lend themselves to the benefits of Write-Once media: permanence of the data and capacity per disk.

This section will discuss use of the on-line Utilities, plus some guidelines for integration into application programs. Also in this section important information is included about on-going special considerations.

3.1 BASIC RULES AND CONSIDERATIONS OF WORM

First and foremost, as mentioned, the user must closely examine proposed LRS-10 usage. The buzzwords are BE AWARE. This means take a detailed look at the programs used to act on a file as well as the files themselves.

When examining the programs that act on a file, those that verify data, move it or provide status on it, there is an important rule that must be adhered to.

********** DO NO DELETIONS **********

This is a devious rule, however, for deletions can be hidden. These are the things to watch for:

* CREATION OF TEMPORARY FILES

  This is an immediate danger flag if the working directory is on the WORM media. For obvious reasons this will rapidly eat up platter space and probably render the platter useless. Sometimes the fact that temporary files are used is unknown until researched. Any program or utility that does create temporary files can still be used; just be sure the working directory is root or on a magnetic disk. This caution is important when writing application programs, using existing ones or working from the CLI. An example of a program that creates temporary files is IVERIFY, used for INFOS database verification. Another example is the /S switch used with CLI command FILESTATUS.

* CLI COMMANDS AND UTILITIES WITH DESTRUCTIVE SWITCHES

When using CLI commands or utilities, DO NOT use the DELETE command and BE CAREFUL to avoid switches such as /R AND /D that delete files. For example, using /O with the SORT/MERGE utility will replace a file written on the media with its own output. File replacement should not be performed on the LRS-10. A convenient way to add updated files to the disk is discussed in Section 3.6.5. Other CLI commands that have dangerous switches are: COPY, DUMP, ENQUEUE, LOAD, MOVE, QSUBMIT and QPRINT.

* CHANGING A FILE

Files written on the optical media may be appended to, or even SLIGHTLY modified with no adverse affect because of the Scrub/Append feature of the LRS-10. However, this feature in no way can compensate for entire updates of a file. For this reason ALL EDITING FUNCTIONS SHOULD BE PERFORMED ON THE FILE BEFORE ARCHIVAL on optical media. Using any editor to act on a file already burned into the media may cause back-up files to be created or multiple automatic rewrites of the entire file. Unless the user is completely aware of all actions an editor will perform on a file and can be assured that none are destructive, the editor should not be used on a file already archived. An example of an editor that causes a back-up file to be created is SED.

3.2 OPTIMIZING PERFORMANCE WITH WRITE DIRECT

There are certain factors affecting performance that cannot be changed. For example, the RPM statistics for the optical drive reflect the fact that it physically takes longer to burn media than cause a flux reversal. Therefore using optical media is slower than magnetic media.

Other factors that impact performance can be adjusted. Because of the caching methods employed to fool the system about the write once nature of the LRS-10, operational overhead is added when a lot of caching occurs. However, as mentioned in the THEORY OF OPERATION in Section 4.2.1, a WRITE DIRECT feature of the LRS-10 is available to offset this occurrence.

The less caching, the better performance response obtained. Write Direct is a decision making process in which the LRS-10 controller either puts data onto the magnetic drive to offset rewrites to that sector or writes the data directly onto the optical media with no stopover on the magnetic. There are certain aspects to a file that encourage Write Direct and certain ones that hinder it. How these aspects can be best put to use will be addressed here.

3.2.1 FILE ELEMENT SIZE AND WRITE DIRECT

The element size of a file is defined as the smallest number of blocks a file may grow by. This number is configurable at sysgen and also when using the CREATE command. Using the FILESTATUS command with /ELE as a switch will output the element size for any file. The number used for element size must be a multiple of four. Default for AOS/VS is 4.

Element size is important because the Write Direct feature decision making is tied to the number of sectors transferred at a time. Of the data to be written during a file archive, the most volatile is directory information. Since this is changed most often, it should reside in the magnetic cache. Because most directory information only consumes one sector, one sector writes are always cached.

For element sizes specified that are over 4, AOS/VS reserves disk space by writing zeroes to that many consecutive sectors. The system then goes back to fill these in with real data, four sectors at a time. Sometimes all reserved sectors are written at once with no gaps. Other times all sectors of an element size are not needed and so not filled. In the case of element size larger than four, the LRS-10 retains the dummy write of zeroes in on-board memory and waits for the fill-in by groups of four. If all zeroed memory is filled, data is written directly to the optical media. If however, only a portion of the zeroed memory is written to, data is cached to the magnetic.

When the element size of a file is exactly four, something different occurs. In this case, no prepatory zeroes are written by AOS/VS. The LRS-10 always performs a Write Direct.

3.2.2 PERFORMANCE AND ELEMENT SIZE

Given the above information, it might be assumed that an element size of four is always the best to improve transfer rate. This can be true if the method of sector fill-in on files with element size greater than four is not sequential. In this case the Write direct feature will not be employed and four would be a better choice for element size. However, it must be remembered that, interspersed with data writes are directory writes. These are always cached. When a file grows by increments of four, many more directory writes are needed for the same amount of data. As shown in Table 3.1, this can actually decrease performance.

The same can be said of archiving a directory structure with data in many subdirectories. Overall speed will be decreased due to directory activity.

Table 3.1 Element Size and Caching

32 SECTORS OF DATA ARCHIVED WITH AN ELEMENT SIZE OF:

SECTOR WRITES	4	32
		32
	4	4
	1	4
	4	4
	1	4
	4	4
	1	4
	4	4
	1	4
	4	1
	1	
	4	1 cached sector
	1	
	4	
	1	
	4	
	1	
	8 cached sectors	

Because of its decision-making complexity, the Write Direct feature is sensitive to non-standard file structure. For this reason, the Write Direct feature is defeated by the archive utilities DUMP-11 and LOAD_11. To provide higher speed transfers, file structure is reorganized in some manner that forces the LRS-10 to continually cache. THESE UTILITIES SHOULD NEVER BE USED WITH THE LRS-10.

To summarize, the user must be aware of the type and configuration of files being transferred as well as transfer utility, in order to determine the best method to optimize. The user must remember:

1. The magic number for Write Direct is four, but a larger element size may be beneficial if all archival is sequential.

2. Large files of data information will be archived more quickly than directory structures.

3. Archive utilities differ in how archives are performed and so performance may differ too.

3.3 OTHER FACTORS AFFECTING PERFORMANCE

Another area where consideration should be made is the number of processes a system has going when the LRS-10 is in use. A system with many users on-line, all transacting business, may find system throughput degraded when archiving to the LRS-10. Conversely, the LRS-10 may become very slow. Adjustment of BMC priority and burst rate may be used to attempt improvement, but the best solution may be to limit archival to low usage times. The LRS-10 is closer in speed to a tape drive than a magnetic disk.

3.4 THE WORM LEARNING CURVE

The LRS-10 is like no other disk subsystem available. The user must precisely control its functions and be aware of all conditions affecting its operation. If not, platters can be laid to waste and data lost from incorrect usage. It is for this reason that the first platter, from init to platter completion, should be treated as a test. This means that the data being archived on this platter should be either easily reproduced or kept extant in other (magnetic) files.

3.5 USING THE ON-LINE UTILITIES

The following sections describe the ON-LINE utilities and their functions. The contents of the files that make up the program can be examined using the TYPE command. It may be useful to do this as an example of the types of commands used for archiving to the optical disk. These files may also be modified, if necessary, by an experienced DG programmer.

3.6 BASIC OPERATIONS

In day-to-day operations with the LRS-10, you will primarily be "mounting" and "dismounting" platters, storing data on them, and accessing that data. In this discussion we assume you are familiar with DG system software and have access to documentation on it.

The following sections discuss the basic subsystem operations such as: mounting/dismounting platters, active/complete platters, monitoring platter space, data transfer and platter organization. The discussion involves use of ONLINE utilities to accomplish these as well as basic CLI commands.

Below is the ON-LINE Utilities Menu.

```
        (L)aser (R)ecording (S)ubsystem Menu
                    Revision 2

 0 - Help
 1 - Mount a Platter
 2 - Dismount a Platter
 3 - Create a Subdirectory on Optical Platter
 4 - Create a Control Point Directory on Optical Platter
 5 - Archive File(s) to Optical Platter - Interactive Job
 6 - Archive File(s) to Optical Platter - Batch Job
 7 - Display filestatus information on Optical Platter
 8 - Show space usage on Optical Platter
10 - User-defined Function 1
11 - User-defined Function 2
90 - Run Recover PROGRAM
91 - Run PROGRAM to Backup/Restore Magnetic Disk
92 - Run Platter Completion PROGRAM
93 - Run Stand-Among DFMTR
99 - Exit
```

3.6.1 MOUNTING AND DISMOUNTING PLATTERS

The term "mount" is actually the same command as "INIT", the common AOS and AOS/VS practice of grafting an independently formatted LDU (in this case, your optical platter) onto the system LDU in order to work with it. It is a system-level logical operation.

You must mount (or INIT) a platter each time before you try to access the LRS-10 at the system level.

In ZETACO's On-Line Utility program, this is done with the MOUNT option. You must know the Logical Disk Name (asked for in the program as the "Platter Name") and the device name. The Logical Disk Name is the name you assigned to the platter when you ran DFMTR. The device name is the "DPJx" name you assigned at the same time.

In the CLI, with the INITIALIZE command, if you had run DFMTR on your optical platter as device DPJ10, the CLI command would be "INIT @DPJ10." The system would then print on the screen the Logical Disk Name of the platter.

The term "dismount" of course refers to the logical disconnection of the grafted LDU when you are through using it. We recommend that you dismount whenever you finish the series of operations for which you mounted the subsystem. In the On-Line Utility choose the DISMOUNT option; in the CLI, use the RELEASE command.

3.6.2 ACTIVE AND COMPLETED PLATTERS

When you run DFMTR on a blank platter, the Controller automatically executes a series of operations that "bind" that platter to the magnetic disk drive cache unit. That platter is then considered "active" and can be written to. It remains so until a special completion operation is run that terminates the relationship by moving all information from the cache to the optical platter. The platter is then considered "completed" and becomes a read-only platter.

Platter completion should not be done until that side of the platter (about 1GB capacity) is full, or contains as much data as you ever want to have on it (see Section 3.3). The Platter Completion operation can only be done by using either the On-Line or Off-Line Utility program.

Once a platter becomes active, you must complete it before you can write to a new platter. You cannot switch back and forth between active platters, because there can only be one active platter at a time per subsystem. However, you can switch back and forth at will between completed platters in order to retrieve previously stored data. You can also switch between the current active platter and any completed platters.

3.6.3 MONITORING AVAILABLE SPACE ON AN OPTICAL PLATTER

To know when to complete a platter, you must closely monitor the amount of space remaining on it. When the amount of space remaining is not sufficient to hold all of the data to be transferred in the next transfer operation, it is time to complete that platter.

If you use ZETACO's On-Line Utility program to do your tasks, then you will receive a report on available space with the execution of each option. If you do not use the On-Line Utility, then use the CLI SPACE command before you begin to transfer data.

3.6.4 TRANSFERRING DATA TO AN ACTIVE PLATTER

The ARCHIVE option in the On-Line Utility program will automate the process of transferring files from the system disk or a data disk to the LRS-10. If you wish to use the CLI, use the MOVE or COPY commands, but:

DO NOT APPEND THE /D OR /R SWITCHES TO THESE COMMANDS, AND DO NOT USE THE CLI DELETE COMMAND. DELETING FROM THE CLI WILL RESULT IN WASTED PLATTER SPACE.

Where you may once have wished to replace an older version of a file with an updated one, you will now have to preserve the older version and write the new one in a different place. This may mean giving the latest version of the file a new name. For example, suppose you previously MOVEd a file called WIDGET, containing a CAD drawing, from your system disk to your active platter. If you recently updated the file on the system disk by changing the drawing, you might use the COPY command to copy the updated version of WIDGET to a file on the active platter called WIDGET_1. You will then have to remember which is the latest version of the original file.
Another possible solution to this problem is to organize your optical platter into subdirectories, so that you can in fact store two files under the same name.

3.6.5 ORGANIZING YOUR OPTICAL PLATTERS

You can create a directory structure on an active platter just as you would on any other LDU, except that once a subdirectory has been created it cannot be deleted. In the CLI use the CREATE/DIR command; in the On-Line Utility program, use the CREATE SUBDIRECTORIES option.

To see how this might work, let us return to the example cited above. First, we might create subdirectories on our active platter called "QUARTER186", QUARTER286, QUARTER386, and QUARTER486. The original version of WIDGET could be saved under QUARTER186. Then updated versions could be saved under the same name in the other three subdirectories. Thus, the version of WIDGET under QUARTER486 would be the latest version.

3.6.6 OBTAINING FILE STATUS

The CLI command FILESTATUS can be used to obtain information about the file structure on the optical platter. All switches are legal except the /SORT, which creates a temporary file.

This command can be issued through the ON-LINE Utilities also. Here the program asks for the switches to be used with the command as well as the pathname to use.

3.6.7 BACKING UP THE MAGNETIC CACHE

As an extra precaution against loss of data, it may be useful to back-up the magnetic cache to tape at regular intervals. The back-ups would be useful if the magnetic became dysfunctional or its integrity was in question. A drawback here is that all data archived to the platter during the time between back-up and restore would need to be written again, with the scrub space absorbing the rewrites. This amount of data to be rewritten may exceed the capacity of the scrub space.

If the entire cache is full of data when back-up is initiated, depending on the tape drive, more than one tape may be needed to hold it all. In this case a labeled tape must be used. The ON-LINE HELP has information on how to use the back-up program.

3.6.8 THE HELP FUNCTION

The ON-LINE Utilities contain help information through the HELP menu:

HELP TOPICS

1 - An Example
2 - Purpose and Usage of On-Line Utility Menu
3 - General Operation of Programs:
    Back-Up/Restore, Recover, Platter Completion
4 - Back-Up/Restore - NOT Labeled Tape
5 - Back-Up/Restore - Labeled Tape
6 - Back-Up/Restore - When to Use Labeled Tape
7 - User-defined Functions
99 EXIT

4.0 TROUBLE-SHOOTING

The LRS-10 is supported by ZETACO in the following ways:

- Microprocessor-based self-test of over 90% of the Controller each time it is powered up, with an LED status report.

- Utility programs on 9-track tape for use during installation and trouble-shooting.

- Customer Support Hotline, manned from 8:00 a.m. to 5:00 p.m. (Central Time) to answer your questions.

- Quick turnaround on subsystem components returned to the factory for repair or replacement.

- Warranties on workmanship and materials

4.1 ERRORS DURING SYSTEM OPERATION

When a subsystem becomes dysfunctional, it can be helpful to take time to observe the LEDs on the front of the board.

Besides the error codes flashed at power-up to indicate failure, there are 4 operational error codes that may occur. See Appendix F if the error code flashed is 12, this may indicate the optical drive is not powered on or connected correctly.

4.2 BASIC TROUBLE-SHOOTING USING THE RECOVER PROGRAM

With the RECOVER program, the user has access to information about any error condition that may have occurred within the optical subsystem. This is important because the optical subsystem, though emulating a magnetic disk is different from one. Most error conditions within the optical subsystem that are alien to AOS or AOS/VS syntax cause it to go offline. When this occurs, the problem can be readily diagnosed by using the RECOVER program to look at the controller error log.

This program also makes available other commands that allow the knowledgeable user to analyze further or even change the condition of the subsystem. The program does not explain what its options do, so a basic understanding of several key concepts is necessary for the user to benefit from its use. To this end, the following Theory of Operation provides a brief description of: the Cache Table, Magnetic and Optical keys, Scrub Directory, and Initialize/Complete processes.

4.2.1 THEORY OF OPERATION

To protect the write-once nature of the optical from excessive rewrites, the LRS-10 uses a small magnetic drive to hold data before it goes to permanent storage on the optical disk. Organization of the data is accomplished by means of the Cache Table; the Keys provide identification to match the currently active platter to the data on the magnetic; the Scrub system is used to provide flexibility in case of rewrites; the Initialize/Complete processes provide continuity and control between platters.

4.2.1.1 INITIALIZE/COMPLETE PROCESSES

Because of the relationship of the magnetic data to the optical data, only one optical cartridge at a time can be written to. Available space on the platter must be monitored and, when nearing capacity, the user must instruct the controller to transfer all data on the magnetic onto the optical disk. This is called "completing a platter" (or purge). The platter then becomes read-only media and is referred to as a "completed platter".

All the user need do next is insert a blank platter and the subsystem will automatically "initialize" (or adopt) it. This initialization logically mates the new platter to the magnetic to make it writable media. It is called an "active" platter. Any previously completed platter from any subsystem can be read at any time.

4.2.1.2 CACHE TABLE

In theory, every write goes to the magnetic before the optical, but in practice, through sophisticated algorithms, a write direct feature is readily used to increase throughput and speed the write function. It is the frequently accessed, single sector writes that tend to be kept in the magnetic cache. Most often these will be the sectors containing directory information.

Since data can be, transparent to the user, either on the magnetic or optical drive, an efficient means of ascertaining the location of data on a read or rewrite is imperative. The LRS-10 uses a look-up table for this. Information about which sectors reside in the magnetic cache is kept in the table. Two copies written on the magnetic drive are alternately updated from the table in controller DRAM.

To cache a sector of data, the controller splits the system address of the data. It uses the lower bits as an offset into the cache table. The upper bits, along with a Valid Entry flag and several bits reserved for access count, become the contents of the table entry. The controller checks the cache table for any system address being written before it is written. Each read command must also check the cache.

In addressing one gigabyte of data, the lower bits become redundant without the upper bits to define them. For this reason, the cache table allows 16 entries per lower address bits to contain different upper address information. The location of the actual data cached on the magnetic is related to the position of the entry in the cache table. When all 16 entries defined by a lower address are full, the controller determines, by means of the constantly updated access counter, which entry has been accessed least. The data associated with that entry is written to the platter and the Entry flag is written to Invalid to indicate an empty entry.

4.2.1.3 MAGNETIC KEY

The controller is able to distinguish platter characteristics by means of a key, written on the 1st 5 sectors of 10 sectors reserved on a platter during initialization. A matching key is also written on the magnetic at this time. Information about whether the platter is active or completed is available in the key. The magnetic and optical keys must be identical or all subsystem activity is disallowed. On a completed platter, the remaining 5 sectors of the reserved key area are written to a completed state. This occurs during the "purge" function (or act of writing all data on magnetic to optical platter). A completed platter is always readable, even when the magnetic has a key that is related to an active platter.

4.2.1.4 SCRUB SYSTEM

A portion of each optical platter is reserved as a Scrub area. Because of the write-once nature of the optical media, any attempt to rewrite a block already on the platter would cause an error. The LRS-10 however, forgives a certain amount of rewriting by accepting the rewrite data, caching it again, and then writing it out to the reserved scrub area when it becomes the oldest entry. The addresses of scrubbed blocks are kept in a scrub directory which is searched for the needed address before any read or write. Multiple copies of the scrub directory are kept on the magnetic drive in case of corruption. At the time of platter completion, three copies of the scrub directory are written to the optical platter to insure future readability.

4.3 USING THE RECOVER PROGRAM

The Recover Program is available to the user in either a Stand-Alone or Stand-Among format. As a Stand-Among program it is available through the on-line Utilities menu. The system need not be brought down to use it. However, the Stand-Alone version requires the system to be down. This version can be booted from tape. See Section 2.15 for instructions on how to load.

The Recover Program has many options. It was put together to provide a means to view and interpret the many complicated facets of the LRS-10. Some of the provided options are immediately useful. Others may never be used, except as a window through which to see the properly functioning subsystem.

The program can be split into 3 categories of use to be discussed: Analysis, Comparison and Advanced Functions. The first two categories will be the most useful to the casual user and so will be discussed at greater length than the last.

For the Stand-Among version, the user must know the device name used at SYSGEN. The Main Menu to RECOVER looks like this:

```
                    LRS RECOVER MENU

        A - Analyze Error Log
        B - Analyze Scrub Directory
        C - Analyze Cache Table
        D - Analyze Subsystem State
        E - Disk Key Functions
        F - Read/Display Subsystem
        G - Display/Modify Subsystem
        I - Compare Two Cache Tables
        J - Compare Two Scrub Directories
        K - Analyze Execution Log
        L - Locate Block in Subsystem
        Q - Quit

        Choice? A
```

4.3.1 ANALYZE FUNCTIONS

The Analyze Functions are options A, B, C, D and K in the Main Menu. They all interpret information in tables and logs and display it to the user in a meaningful way. Use of these functions does not alter or complicate the state of the subsystem.

4.3.1.1 THE ERROR LOG

This option provides an important link in subsystem usage. It is a tool that allows the user to obtain detailed information about the subsystem state.

An example:

ERROR LOG

```
ERROR CODE:  0023
MEANING:  Read of Optical disk key returned hard error other than
blank.

UNIT: 0000                              SCSI CONTROL BLOCK ERRORS: 2000
DRIVER STATUS: 0000                     RETURNED SCSI STATUS: 0002
SCSI MESSAGE-IN BUFFER: 0000            SCSI MESSAGE-OUT BUFFER: 0080
INTERFACE STATUS: 2000                  INTEFACE ERRORS: 0000
DRIVER CONTROL BLOCK OFFSET             INSTRUCTION POINTER REGISTER: 07
  (BPREG): 455C

SCSI COMMAND DESCRIPTORS:
        0028  0000  0000  0000  0000  0009  0000  0000  0001  0000
(byte:)    0     1     2     3     4     5     6     7     8     9

5380 READ BYTES:
        0000  0000  0000  0007  0000  0000  0000  0000
(reg:)     0     1     2     3     4     5     6     7

REQUEST SENSE BYTES:
        0070  0000  0002  0000  0000  0000  0000  0008
        0000  0001  0000  0001  0010  0080  0000  0000
(bytes:)0/8   1/9   2/10  3/11  4/12  5/13  6/14  7/15

Do you want to see the previous entry (Y or [N])?  Y
```

The Error Log has several layers of complexity. At the friendliest level, it reports the meaning of any error code generated inside the subsystem. This may be enough information alone to discover the problem. Error codes are divided into categories: Initialization, Online, Platter Completion, and Extended or Offline errors. A complete reference of these is in Appendix H.

Further investigation requires access to the LMSI SCSI Reference Manual (P/N 75110023). Using this, the user can decipher the meaning of the Request Sense bytes and the SCSI Command descriptors.

A dedicated user could also benefit from an NCR 5380 data book to glean information from the provided 5380 Read bytes.

The rest of the information in the log would require access to the controller microcode source to interpret. This information may be requested for their use by Zetaco Product/Customer Support. (See Section 4.5.)

4.3.1.2 ANALYZE SCRUB DIRECTORY

Choosing option B from the RECOVER Main Menu displays a sub-menu as follows:

```
Choice?  B

A - From D-Ram
B - Magnetic Disk Copy 1
C - Magnetic Disk Copy 2
D - Optical Disk Copy 1
E - Optical Disk Copy 2
F - Optical Disk Copy 3
Q - Quit This Menu
```

The user can choose which copy to analyze.

The program does its analyses without any further interaction from the user. NOTE that there will be no copies of this directory on the optical disk unless the platter is completed.

This is an example of the output:

```
Enter Selection:  A

Checksum is correct.
The event counters are equal.
  NOTE:  Values are for Optical (1024 bytes) sectors.
Scrub space size is ABA8
Next free sector in scrub space is 0000
The number of entries found in the scrub directory was 0
 *** Scrub Directory analysis complete ***

Enter C to continue:  C
```

The program refigures the checksum of the directory and examines the event counters. If either of these are in error a message to that effect would be displayed. If one copy is corrupt, the subsystem would use one of the others to function. The analysis also reports the size of the scrub space, the number of scrubbed entries and the next free sector in the scrub space.

4.3.1.3 ANALYZE CACHE TABLE

The sub-menu for choice C displays as follows:

```
Choice? C

        ANALYZE CACHE TABLE

A - From D-Ram
B - From Magnetic Disk
Q - Quit This Menu

Enter Selection: A
```

If the second option is chosen, the program picks the most recently updated table to analyze. The analysis is looking for errored entries in the table and for corruption of the table itself. A good outcome would print the following screen:

```
Cache head Checksum IS good.

Cache tail Checksum IS good.
Cache head and tail DO match.
No errors found in cache table.
 *** Cache table analysis complete ***

Enter C to continue: C
```

4.3.1.4 ANALYZE SUBSYSTEM

Choice D picks the following sub-menu:

```
        ANALYZE SUBSYSTEM

A - Magnetic Key 1
B - Magnetic Key 2
C - Optical Key
D - Disk Parameter Block from ARZ-1 RAM
E - Compare all keys
Q - Quit

Choice? E
```

The most useful tool offered here for the user is to determine the state the keys are in. This will report whether the key on optical or magnetic is active, complete in error, etc. Also, all keys can be compared to find discrepancies.

```
Choice? E
  Magnetic Key 1 vs. Magnetic Key 2:  No differences.

  Disk Parameter Block vs. Magnetic Key 1:  No differences.

  Disk Parameter Block vs. Magnetic Key 2:  No differences.

  Disk Parameter Block vs. Optical Key:  No differences.

  Magnetic Key 1 vs. Optical Key:  No differences.

  Magnetic Key 2 vs. Optical Key:  No differences.

Enter C to continue:  C
```

4.3.1.5 ANALYZE EXECUTION LOG

Selection of option K from the Main Menu provides a look at the event counter information. With the event counter, the user can examine what commands are being passed to the peripheral devices. Unit zero is the optical drive. Although the magnetic disk is logically unit 3, it is physically unit 4. Event information pertaining to unit 4 refers to the magnetic disk.

```
EVENT COUNTER: 02F1

SCSI COMMAND DESCRIPTORS:
       0028  0000  0000  0000  0000  0082  0000  0000  0080  0000
(byte:)   0     1     2     3     4     5     6     7     8     9
UNIT: 0004
SCSI MESSAGE-OUT BUFFER: 0080
SCSI STATUS BYTE: 0000
INFORMATION BYTES:
       0000  0000  0000  0000  0000  0000  0000  0000
       0000  0000  0000  0000  0000  0000  0000  0000
(bytes:)0/8   1/9   2/10  3/11  4/12  5/13  6/14  7/15

Do you want to see the previous entry (Y or [N])?  Y
                  EXECUTION LOG

EVENT COUNTER: 02F0
SCSI COMMAND DESCRIPTORS:
       0028  0000  0000  0000  0001  0082  0000  0001  0002  0000
(byte:)   0     1     2     3     4     5     6     7     8     9
UNIT: 0004
SCSI MESSAGE-OUT BUFFER: 0080
SCSI STATUS BYTE: 0000
INFORMATION BYTES:
       0000  0000  0000  0000  0000  0000  0000  0000
       0000  0000  0000  0000  0000  0000  0000  0000
(bytes:)0/8   1/9   2/10  3/11  4/12  5/13  6/14  7/15
```

Access to an LMSI (optical drive) and/or CDC (magnetic drive) SCSI Reference Manual is required to interpret the SCSI Command descriptors. Also, the information bytes equate to the request sense bytes translated in the same manual.

4.3.2 COMPARISON FUNCTIONS

The next category of RECOVER functions is Comparison. There are only two compare functions; for the cache tables and for the scrub directories. Again, use of these functions does not interfere with or change the subsystem state.

4.3.2.1 CACHE TABLE COMPARE

Since 3 copies of this table are kept updated, it can be useful to diagnose dysfunction if there are discrepancies. Selection of "1" from the Main Menu brings this sub-menu:

```
          COMPARE TWO CACHE TABLES

     A - Magnetic Table 1 vs. Magnetic Table 2
     B - Magnetic Table 1 vs. D-Ram
     C - D-Ram vs. Magnetic Table 2
     Q - Quit This Menu

     Enter Selection:  A
     Two copies are NOT equal.
```

The choice of A from the sub-menu proved to provide no match between the two tables. This is not surprising since the tables are alternately updated. To determine which is the most recent, the next choice would be appropriate.

```
          COMPARE TWO CACHE TABLES

     A - Magnetic Table 1 vs. Magnetic Table 2
     B - Magnetic Table 1 vs. D-Ram
     C - D-Ram vs. Magnetic Table 2
     Q - Quit This Menu

     Enter Selection:  B
     Two copies are identical.
```

In this case, the copies match, so Table 1 on the magnetic is the most current table.

4.3.2.2 SCRUB DIRECTORY COMPARISONS

Selection option J from the Main Menu brings up two sequential sub-menus:

```
          FIRST COPY OF SCRUB DIRECTORY TO COMPARE

A - From D-Ram
B - Magnetic Disk Copy 1
C - Magnetic Disk Copy 2
D - Optical Disk Copy 1
E - Optical Disk Copy 2
F - Optical Disk Copy 3
Q - Quit This Menu

Enter Selection:  A

          SECOND COPY OF SCRUB DIRECTORY TO COMPARE

A - From D-Ram
B - Magnetic Disk Copy 1
C - Magnetic Disk Copy 2
D - Optical Disk Copy 1
E - Optical Disk Copy 2
F - Optical Disk Copy 3
Q - Quit This Menu

Enter Selection:  B
Two copies are identical.

Enter C to continue:  C
```

From these comparisons the user can ascertain if the directory copies are intact. Please note that the scrub directory resides on the optical disk only after the platter has been completed (made READ-ONLY).

4.3.3 ADVANCED FUNCTIONS

The advanced functions are options E, F, G and L in the Main Menu. Some of these functions are designed to change the current state of the subsystem. For this reason, caution should be exercized when using them.

4.3.3.1 DISK KEY FUNCTIONS

Choosing E from the Main Menu displays the following sub-menu:

```
        DISK KEY FUNCTIONS

    A - Copy Optical Key to Magnetic Key
    B - Set Magnetic Key Active
    C - Set Magnetic Key Empty
    Q - Quit

    Choice? Q
```

All of these functions change the condition of the key and so affect the subsystem workings.

A Makes the magnetic key identical to the optical key. To use this, a good key must exist on the optical. This can be used to force the subsystem parts to interact. Caution must be used here because forcing interaction does not mean the parts will be compatible.

B Turns an errored or empty key into an active one. This is useful if an error condition has been fixed.

C Sets the key to a "ready for initialization" state. When empty, a new platter can be adopted. This is automatically done when the "complete" or purge command is given to the subsystem.

4.3.3.2 READ/DISPLAY SUBSYSTEM

Choice of option F from the Main Menu brings up this sub-menu:

```
    Choice: F

        READ AND DISPLAY

    A - Magnetic Key 1
    B - Magnetic Key 2
    C - Optical Key
    D - Disk Parameter Block from ARZ-1 RAM
    E - Magnetic Disk Block
    F - Read (Logical) Optical Disk Block to Disk Buffer
    G - Display LRS Controller RAM
    H - Salvage Optical Blocks
    Q - Quit
```

A,B Will display only the data making up the key; no analysis is done. See Appendix H for the layout of the key.

C Displays key read from optical without analysis. See Appendix H for layout of the key.

D Displays data used by subsystem to reference addresses of cache table, scrub directory, microcode, etc. Parameter Block Layout is provided in Appendix H.

E Will display any block requested from the magnetic.

F Reads any block from the optical disk.

G General purpose command to display SCSI side DRAM.

H Issues SCSI Salvage command to optical disk. This command reads in header information of a sector as well as the data there.

The output from choice A looks like this:

```
Choice? A

Addr
/0000    00B4  2020  2020  2020  2020  2020  2020  2020
/0008    2020  2020  2020  2020  2020  2020  2020  2020
 ***
/0018    2020  0001  0000  0005  0000  0000  0024  0000

/0020    004C  0000  0080  0000  0082  0000  0182  0000
/0028    0386  0000  0386  0002  0400  0002  5D9F  0002
/0030    0000  0000  5380  000E  FF28  000E  FFFE  000E
/0038    ABA8  0000  0000  0001  0000  005F  0400  007C
/0040    0001  005F  7F5C  55D4  0000  0000  0000  0000
 ***
/0078    0000  0000  0000  0000  0000  0000  A5BD  00A4
/0080    0005  0000  0000  0000  0000  0000  0000  0000
/0088    0000  0000  0000  0000  0000  0000  0000  0000
 ***
/00A8    0000  0000  0000  0000  0000  000B  76A0  0000
/00B0    0000  0000  0000  8878  0000  0020  0000  4516
/00B8    0000  0000  0000  0000  0000  0000  0000  0000
 ***
/00F8    0000  0000  0000  0000  0000  0000  0000  0000
Press New Line to continue:
```

4.3.3.3 DISPLAY/MODIFY SUBSYSTEM

This option is locked for general use. The program will ask for a password when G is chosen from the Main Menu. The commands available in the sub-menu of this option are useful to ZETACO personnel when trouble-shooting.

4.3.3.4 LOCATE BLOCK IN SUBSYSTEM

When L is selected from the Main Menu, the user is asked what Operating System Block number to locate. The operating system block number is the block number or address given to the LRS-10 in the Argus control block. This tool is useful to determine whether any given block is on the magnetic or optical. The program searches through the cache table first to find if the block is in cache. If not, the scrub directory is searched. If the scrub directory does not contain this block address, the block is assumed to be on the optical in non-scrub space. The option to display the block in question is given in all 3 cases. If all zeroes are displayed from an optical read, it can be assumed that the block was blank:

```
Choice? L
Enter Operating System Block Number (in HEX) to locate: 1369

Searching Cache Table ..... Block NOT located in Cache Table.

Do you want to read it from Optical Platter ([N]/Y)? Y
Optical Block # = 0000  1369

Addr
/0000    0000   0000   0000   0000   0000   0000   0000   0000
  ***
/00F8    0000   0000   0000   0000   0000   0000   0000   0000
Press New Line to continue:

Enter C to continue:  C
```

Otherwise, the display looks like this:

```
Choice?  L

Addr
/0000     0000    0000    0000    0000    0000    0000    0000    0000
 ***
/0028     0320    00C1    0000    0000    1D37    3C9B    001F    000A
/0030     0007    0000    0000    0000    2800    0000    0001    0000
/0038     08EC    0103    0007    0000    1D3D    649F    1D37    4525
/0040     0000    0000    0000    0000    0000    0000    0000    0000
/0048     0320    0001    0000    00000   1D37    3C9E    001F    000A
/0050     0007    0000    0000    0000    1200    0000    0001    0000
/0058     0F3F    0103    0000    0000    1D3D    6480    1D37    3C9E
/0060     0000    0000    0000    0000    0000    0000    0000    0000
/0068     0320    0021    0000    0000    1D37    3CB5    001F    000C
/0070     0007    0000    0000    0000    1200    0000    0001    0000
/0078     0F42    0103    0000    0000    1D37    4030    1D37    3CB5
/0080     0000    0000    0000    0002    0001    86A0    0000    0000
/0088     0320    0041    0000    0000    1D37    3CB8    001F    000C
/0090     0007    0000    0000    0000    4000    0000    0001    0000
/0098     0089    0103    0000    0000    1D37    40AD    1D37    40AD
/00A0     0000    0000    0000    0863    0001    86A0    0000    0000
/00A8     0000    00F1    4F50    001F    0000    0000    0000    0000
/00B0     0000    0000    0000    0000    0000    0000    0000    0000
Press New Line to continue:

Addr
/00B8     0000    00000   0000    0000    0000    0000    0000    0000
 ***
/00F8     0000    0000    0000    0000    0000    0000    0000    0000
Press New Line to continue:

Enter C to continue:  C
```

4.4 TESTING A MAGNETIC DISK WITH DATA ON IT

Occasionally you may wish to run off-line tests on your magnetic disk, even though you have current data stored on it. In this section we will briefly describe two ways you can do this, using the Reliability program.

The first way tests the whole disk, but in a READ-ONLY mode. Although it does not test write capability, it can be useful for testing the Controller's ability to seek, read data from the disk, and transfer data on the BMC.

Boot the program and respond to its questions as outlined in Section 2.13, with two exceptions: 1) When it asks, "READ ONLY (YES/[NO]):", answer YES. 2) When it asks, "VERIFY DATA ([YES]/NO):", answer NO. Now start the Reliability program with the "S" command.

The second method allows writing as well as reading, but only tests a portion of the disk. This portion is called the "maintenance area". It is an unused area on the disk that can essentially be used as a "scratch pad" for testing. The starting block of this area is always the default minimum logical block when you are in Maintenance Mode. The ending block is the last useable block on the magnetic disk, given as the default maximum logic block.

To use the maintenance area you MUST be in Maintenance Mode. Enter ("E" command) unit 3. Select the defaults for the minimum and maximum logical blocks by entering "<cr>". Of course, you can enter a disk block GREATER THAN the minimum block default, but DO NOT ENTER ONE LESS THAN THE DEFAULT OR YOU WILL WRITE OVER SYSTEM DATA. You can now run the program as you normally would.

4.5 CUSTOMER SUPPORT HOTLINE

ZETACO, Inc. provides a Customer Support Hotline (612-941-5825 or 1-800-537-5292) 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.

4.6 WARRANTY INFORMATION

The Magnetic Disk and Optical Drive Modules are warranted free from manufacturing and material defects, when used in a normal and proper manner, for a period of six months from date of shipment.

The LRS-10 Controller is warranted free from manufacturing and material defects, when used in a normal and proper manner, for a period of two years from date of shipment.

EXCEPT FOR THE EXPRESS WARRANTIES STATED ABOVE, ZETACO DISCLAIMS ALL WARRANTIES INCLUDING ALL IMPLIED WARRANTIES 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.

If a part is no longer under warranty, or if the problem is not warranted (as set forth above), then repair will be on a time-and-material basis.

4.7 PRODUCT RETURN AUTHORIZATION

All possible effort to test a suspected malfunctioning component of the LRS-10 should be made before returning it to ZETACO for repair. However, if Controller or module malfunction has been confirmed using the tests outlined in Sections 4.1 through 4.4, you should return the part to: ZETACO, 6850 Shady Oak Road, Eden Prairie, MN 55344, freight prepaid.

A Return Material Authorization (RMA) number is required before shipment and should be referenced in all future correspondence about the part in question. RMA numbers are obtained by calling the Customer Support Hotline (see Section 4.5). To ensure prompt response, the information outlined in the Material Return Information form on the following page should be gathered before calling the ZETACO Hotline for the RMA number. Please include a completed copy of the Material Return Information form with the product. Each product to be returned requires a separate RMA number and Material Return Information Form.

Upon ZETACO's verification of defect, defective parts shall be repaired or replaced, and returned surface freight prepaid to the customer. In most cases, the Magnetic Disk Drive and Optical Drive Modules will be returned within thirty working days, and the Controller within two.

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

MATERIAL RETURN INFORMATION

The speed and accuracy of a product's repair is often dependent upon a complete understanding of the user's checkout test results, problem characteristics, and the user system configuration. Use the form below to record the results of your trouble-shooting procedures. If more space is needed, use additional sheets.

TEST	RESULT
Power-up Self-test	

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? (ERDOS, AOS, AOS/VS) Include revision number.

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

4. Has the unit 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: _____

APPENDIX A

A.0 OFFLINE UTILITIES AND RELIABILITY

The Off-Line Subsystem Utility performs functions primarily concerned with installation and maintenance of the subsystem. The Off-Line Subsystem Utility is a stand-alone program, which means that you cannot run it under the control of the operating system. Instead, you must shut down the operating system and load the program, either from the Software Support Tape or your system disk.

The Reliability program is available to verify operational integrity. Its value as a trouble-shooting method is limited because it will use up write-once media with unintelligent data. Also, error messages from the program are difficult to apply to the special circumstances of write-once media. Therefore, it is most useful for testing the magnetic cache for faults or for use with a maintenance platter.

A.1 THE OFF-LINE SUBSYSTEM UTILITY

A.1.1 LOADING AND RUNNING THE PROGRAM

In Section 2.15 you loaded LRS-10 software onto your system disk. Therefore, you will probably want to load the program from your system disk, rather than from the Software Support Tape. To do so, you must first shut down the operating system according to standard AOS or AOS/VS practice.

Once this has been accomplished, do a "Program Load" to your system disk. This procedure differs for the various DG computers; if you are unsure of the procedure for your system, consult your DG system documentation. When the system finally prompts for a filename, enter "LRSU."

If you do wish to load from tape, mount the Software Support Tape on your magnetic tape drive and do your "Program Load" to that device instead of the system disk. When the Software Support Tape menu appears on your screen, enter the number of the LRSU program.

A.1.2 THE PROGRAM OPTIONS

The following is a complete list of available program options, with comments where they are pertinent.

1. DO ALL: FORMAT, INSTALL FIRMWARE

   This option automates the basic initialization of the Controller and magnetic disk. The individual options are covered below.

2. FORMAT MAGNETIC DISK

   Of course, you must format the disk before you can either install the firmware on it or run DKINIT. It takes about 15 minutes to complete the formatting operation.

   If you have not previously run the INITIALIZE CONTROLLER option, it will be run for you before the formatting operation begins. If you later run the format option again, the initialize routine will NOT run again, unless the Controller has been powered down.

3. INSTALL ARZ FIRMWARE ON MAGNETIC DISK

4. INSTALL SCSI FIRMWARE ON MAGNETIC DISK

   In normal operating mode (Runtime Mode -- see Section 4, THEORY OF OPERATION), the Controller automatically loads its microcode from the magnetic disk. Therefore, in Runtime Mode, THE FIRMWARE MUST BE ON THE MAGNETIC DISK OR THE SYSTEM WILL NOT WORK. If you choose to do a format alone, you must run both of the INSTALL options before you return to normal system operation.

5. INQUIRY THE DRIVE

   The INQUIRY command belongs to the Common Command Set of of the SCSI Interface. When issued, it returns information about the vendor and product for the specified unit. If a vendor has chosen not to provide any information, a program message will report that no data is available.

   For more information on the SCSI Inquiry command, see the SCSI Specification ANSI X3T9.2/82-2

6. (RE)INITIALIZE CONTROLLER

This option transfers the ARZ microcode from the tape onto the Controller. If you do not run it before any of the other options, then the first time you run another option it will run automatically.

You may wish to run this option if for some reason you cannot load the Controller microcode from the magnetic disk, as is normally the case.

7. PLATTER COMPLETION (PURGE OF THE MAGNETIC)

Select this option when you have determined that your active optical platter is nearly full. After you run this option, the platter will be read-only.

8. SET MAGNETIC KEY ACTIVE

This option is used under special circumstances in conjunction with the PLATTER COMPLETION command. It is intended for ZETACO service personnel only.

WARNING: INDISCRIMINATE USE OF THIS COMMAND WILL RESULT IN PERMANENTLY LOST DATA.

---

9. SET MAGNETIC KEY EMPTY

This option is used under special circumstances in conjunction with the PLATTER COMPLETION command. It is intended for ZETACO service personnel only.

WARNING: INDISCRIMINATE USE OF THIS COMMAND WILL RESULT IN PERMANENTLY LOST DATA.

---

10. HELP

This option provides on-screen help with the operation of the program

11. LOGGING TO PRINTER

This option sends information on the screen to the system printer. The printer must be on-line and ready to receive data.

12. QUIT

This command provides for an orderly termination of the program.

A.2 THE RELIABILITY UTILITY

This program is useful as a subsystem exerciser. In Section 2.11 it was used to verify that the installation was successful. This section will discuss the program operation in more detail, some ways to use its various options, and the ways it reports errors.

In order to run the program, the magnetic disk drive must have been previously formatted, and the Controller microcode must have been loaded onto the board. In Runtime mode this will happen automatically if you have installed the microcode on the magnetic disk drive. If you haven't installed the microcode on the disk, or if you will be running in Maintenance Mode, you will need to issue the "R" command in the Off-Line Subsystem Utility program to load microcode onto the board.

The Reliability Utility is a stand-alone program, which means that it does not need, and cannot have, an operating system running when it is executed. It has been written by ZETACO specifically for the LRS-10. DG RELIABILITY, DIAGNOSTIC, AND MVSYSTEMX PROGRAMS WILL NOT WORK ON THIS SUBSYSTEM. All of ZETACO's software has been designed to be as "user-friendly" as possible. Messages about many of the options and program features are displayed on-line, expected or possible responses are suggested, commands are shortened for quick entry. The discussion of the Reliability program that follows is intended as a companion to your on-screen display.

At several points you will find sample dialogues. In these samples, the lines that the computer prints will be entirely in upper case letters. The sample user responses will be on the next line below, indented. The CARRIAGE RETURN response will be designated by "<cr>". Comments and suggestions, which do not appear in an actual session and are here provided for clarification, will be preceeded and followed by the characters "**".

A.2.1 GLOBAL PARAMETERS

These are the over-all operating conditions of the program under which the specific tests for each device must run. They are the display mode, timeout enable, mapping enable, program execution mode, and controller mode.

1. The DISPLAY MODE option allows you to select the numbering system in which some of your on-screen information will be displayed. Decimal numbers will be followed by a "." (eg., 5.). Octal numbers will not. Hex numbers will be either 4 or 8 digits long, and will include any required leading zeroes. However, when entering any number, you need not enter leading zeroes; when entering decimal numbers, you need not enter the ".".

   Note that whenever the program asks for a numeric response, the required numbering system is displayed in parentheses.
   Wherever the program asks for an input, it displays a possible response in brackets []. This is the default response, and is selected simply by entering a carriage-return or new-line.

2. The MAPPING features are defined in the DG Programmer's Reference Series: Models 6236/6237 and 6239/6240 Disk Subsystems.

3. The two PROGRAM EXECUTION MODES are Random and Sequential. In Random Mode the program issues random disk addresses for reading and writing data, while in Sequential Mode the addresses increment serially. Note that you cannot run random data patterns in your tests if you choose Sequential Mode.

   Random Mode is primarily intended for exercising the subsystem. It is difficult to use for trouble-shooting because it involves many variables. For example, CB commands are stacked and continue to execute even after the program halts to report an error. Therefore, if you were to enter the Debugger and examine the register contents, the reported values might not reflect the current state of the Controller.

   Sequential Mode, on the other hand, offers a more tightly controlled environment.

4. The two CONTROLLER MODES are Maintenance and Runtime.

In Maintenance Mode:	Unit 0 = read/write optical drive 0 Unit 1 = read/write optical drive 1 Unit 2 = read/write optical drive 2 Unit 3 = magnetic disk (Optical drive 3 not accessible)
In Runtime Mode:	Unit 0 = cached read/write optical drive 0 Unit 1 = read-only optical drive 1 Unit 2 = read-only optical drive 2 Unit 3 = read-only optical drive 3

A.2.2 THE COMMAND LIST

Basically, when you run the program, you:

1. Select some global program parameters,
2. Enter the devices you want to test and the test specifics for each of them,
3. Run the tests, and
4. Examine the status of each device.

The following is a complete list of available program commands, with comments where they are pertinent.

1. ENTER A DEVICE

For each device the program will ask you to specify minimum and maximum logical block limits within which you want the program to operate. The default value reported for the maximum block will always be the highest useable logical block for that device. The default value for the minimum block is variable:

- In Runtime Mode it will be zero, or whatever you previously set it to.

- In Maintenance Mode, if your device is Unit 3 (the magnetic disk), it will always be the first block of the maintenance area of the magnetic disk. IF YOU HAVE DATA ON THE MAGNETIC DISK THAT YOU WANT TO PRESERVE, DO NOT CHANGE THE MINIMUM BLOCK TO SOMETHING LESS THAN THE DEFAULT. You can, of course, set it higher.

- In Maintenance Mode, if your device is any other unit (ie., an optical drive), it will be zero, or whatever you previously set it to.

The program will ask you if you want to read and/or write, and verify data. In Maintenance Mode, you can only write to your optical drive if you select Sequential testing. You can always read, but if you elect to verify, you must know what data pattern you'll be reading. If you want to test your optical drive in Maintenance Mode, see Appendix G on creating and using a Maintenance Platter.

In Maintenance Mode, the program reports each of the four allowable units (units 0-3) as ready and asks you to select, even though some of those units may not actually exist. In Runtime Mode, if a device does not exist, the program reflects this fact by simply reporting the unit not ready.

If you try to select a device that isn't there, the program accepts the entry. However, when you try to run that device, the program will report errors. You will notice that the left-hand red LED on the Controller is flashing Error Code 12 (see Appendix F, Table F.3) and/or the right-hand Green LED (Host Busy) is solid on. To get out of this error condition you will have to press the CPU reset switch. When the monitor prompt appears, you can restart the program at 500.

If, after running, you want to enter another device, you will have to re-enter the devices you currently have along with the new one.

2. START A DEVICE

This command gives you the option of starting the test on all entered devices, or on any combination of them. The program does not verify that the tests are running, but simply returns to the command list. You can verify that they are running by 1) monitoring the drives and the Green LEDs on the Controller, and 2) doing a List command. This command will return a status report for each entered device (see below).

3. LIST ERROR TOTALS

The resulting display actually gives status information on the device as well as error totals. You can list a device at any time, whether it is running or not. This is useful if you wish to be sure you've entered only what you want entered. However, if you list a newly entered device before it has been run, the mode information displayed will be valid, but the run time, blocks written and read, and number of errors will not.

4. COMMAND LIST

This command allows you to display the program's menu of commands.

5. HALT A DEVICE

You can halt any device or combination of devices without affecting testing on the other ones.

6. DELETE A DEVICE

Once a device is halted, you can delete it, even while other devices are running. Deleting one device does not affect testing on the other entered devices.

7. PRINTER CONTROL

This command allows you to enable or disable your printer during program operation. For example, if you are going to let the program run unattended, you may wish to enable the printer to record error messages.

You can use the command at any time without affecting tests in progress. However, note that the Restart command (see below) will override this command and automatically disable the printer.

8. RESTART THE PROGRAM

The important point to note about this command is that it completely re-initializes the program. You will have to select your operating mode, enter devices, and, if you want a printout, re-enable your printer.

9. FLAGS

Flags are, in effect, "switches" that allow you to alter the flow of the program depending on specific conditions encountered during execution.

The flag available in the Reliability program gives you the choice of whether to halt the program when an error is encountered, or simply log the error and continue with the test. If you choose the default response you will have chosen to log the error and continue. If you choose to halt, the program will do so, log the error, and jump to the Debugger. To leave the Debugger and restart the program, type "RT".

The flag can be changed while the program is running.

10. SOFTWARE DEBUGGER

This is a tool for software maintenance and trouble-shooting. It is intended for ZETACO service personnel only.

11. QUIT

This command allows you to leave the Reliability program.

12. MODIFY DISPLAY MODE

This allows choice of which numerical system (i.e., octal, hex, decimal) should be used for program input and display.

A.2.3 EXAMPLES OF ERRORS REPORTED BY THE PROGRAM

The program will display PIO errors, CB errors, and Data Compare errors.

1. A sample PIO error:

```
**** ERROR **** AT RUN TIME  0. : 1.
DEVICE CODE 24 UNIT NUMBER03 MAPPING NOT ENABLED STATE:ACTIVE
MODES :MAINTENANCE, RANDOM, READ ONLY, DATA CHECK-ROT
              REG A     REG B     REG C
OPERATION       0         0         5
STATUS          0         0     14005
STATUS ERROR ON PIO COMMAND!
```

The display mode is octal

2. A sample CB error:

```
**** ERROR **** : RUN TIME 0. HRS.    0. MINS.
DEVICE CODE 24 UNIT NUMBER03 MAPPING NOT ENABLED STATE:ACTIVE
MODES :MAINTENANCE, RANDOM, READ/WRITE, DATA CHECK-ROT
LOGICAL BLOCK       038A6993     SECTOR COUNT       0004
MEMORY ADDRESS      00005E17     COMMAND            WRITE
PAGE TABLE ADDRESS  00000000     RETURNED XFER COUNT 0000
ASYNC STATUS  :          0003
     CB EXECUTION ERROR: HARD ERRORS
CB STATUS     :          8001
     ANY CB HARD EXECUTION ERROR
     CB DONE BIT
CB ERROR      :          0400
     DRIVE ERROR
CB UNIT STATUS:          2000
     READY
```

The display mode is hexadecimal.

3. A sample Data Compare error:

```
***** DATA COMPARE ERROR *****
DEVICE CODE 24 UNIT NUMBER03 MAPPING NOT ENABLED STATE:ACTIVE
MODES :MAINTENANCE, RANDOM, READ/WRITE, DATA CHECK-ROT
DISK BLOCK           038A6993      SECTOR COUNT           0004
PAGE TABLE ADDRESS  00000000      LOGICAL XFER ADDRESS 00000
PHYSICAL XFERS ADDRESS  00006417
EXPECTED   RECEIVED   OFFSET
  AAAA        8000        0000
  5555        4000        0001
  AAAA        2000        0002
TOTAL ERROR COUNT:     0600
```

The display mode is hexadecimal.
For a complete description of the error statuses refer to the DG Programmer's Reference Series: Models 6236/6237 and 6239/6240 Disk Subsystems.

APPENDIX B

B.0 ADDING ADDITIONAL OPTICAL DRIVES

Since the LRS-10 Controller is capable of controlling up to 4 optical drives, you may at some point wish to add additional drives to your subsystem. This Appendix will provide you with the details to do so.

B.1 SET UP THE SCSI ADDRESS OF THE NEW UNIT

The SCSI Address of an Optical Drive Module is determined by a switch cap labelled "Control Module Address x", where 'x' is a number from 0 to 3. This switch cap is located on the front panel of the drive (see Figure 2.9). With the new unit you will have received a set of four caps (0-3). Control Module Address 0 will have been installed at the factory.

To change caps, simply pull out the presently installed one and gently push the new one into place. The caps have been designed so that they only fit one way. The following table shows which cap to use.

TABLE B.1 SCSI Unit Addressing

LOGICAL UNIT	CONTROL MODULE ADDRESS
First	0
Second	1
Third	2
Fourth	3

NOTE: The SCSI Address of the Magnetic Disk Drive has been set to 4 at the factory.

B.2 CONNECT THE CABLES

1. Disconnect the two-foot External SCSI Cable (300-152-04) from both the Magnetic Disk Drive Module and J17 of the primary (or previous) Optical Drive Module.

2. Locate the new drive between the primary (or previous) Optical Drive Module and the Magnetic Disk Drive Module. Since the Magnetic Disk Drive Module has the SCSI bus terminators installed, it must be at "the end of the line" in the daisy-chain cabling scheme described here.

3. Connect the SCSI Daisy-Chain Cable (P/N 300-151-00) shipped with the new unit from J17 on the rear panel of the previous unit to J18 on the rear panel of the new unit. This FCC-compliant cable has a 50-pin connector block on both ends.

4. Re-connect the two-foot External SCSI Cable between J17 of your new Optical Drive Module and the Magnetic Disk Drive Module.

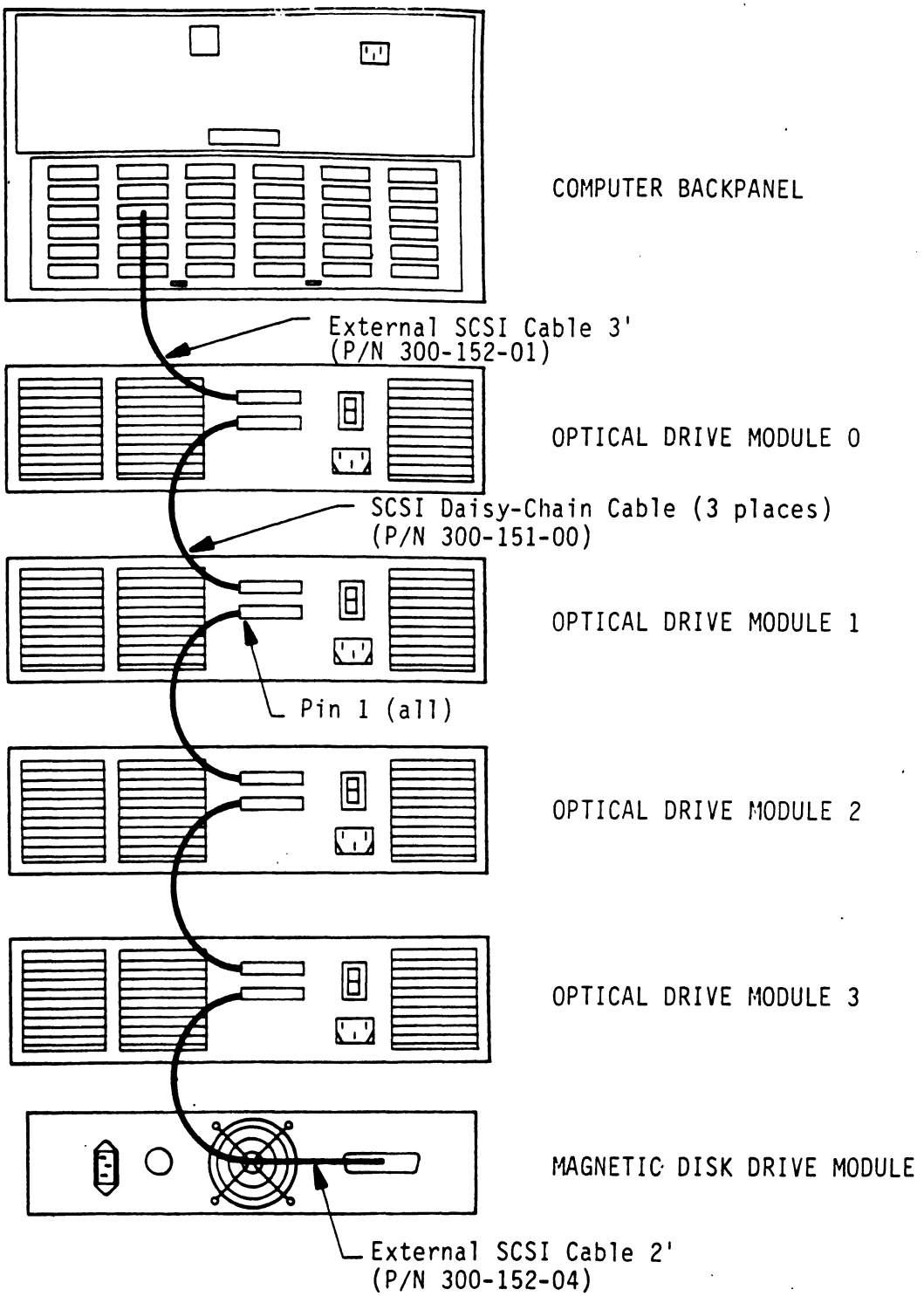
5. If you are only adding a second drive, you can leave the 9-foot cable from the computer bulkhead to the primary Optical Drive Module (P/N 300-152-03) in place. However, if you are adding a third drive, this cable MUST BE REPLACED by the 3-foot External SCSI Cable (P/N 300-152-01) shipped with the new unit. This is done to ensure that a three- or four-drive subsystem will adhere to the maximum cumulative cable length of 6 meters (19.68 feet) specified for the SCSI interface.

Figure B.1 illustrates the daisy-chain arrangement of a fully populated LRS-10.

B.3 CHECK CURRENT CONTROLLER CONFIGURATION

Unless, during original installation you configured for a number of optical drives equal to or greater than the number you now have, you will need to change that configuration fact to reflect your new drives.

FIGURE B.1 Fully Populated LRS-10 (Rear View)



APPENDIX C

C.0 PREVENTIVE MAINTENANCE

C.1 CLEAN THE MAGNETIC DISK DRIVE MODULE AIR FILTER

This should be done AT LEAST every six months, but, depending on site conditions, may be required more frequently.

1. Unplug the AC power cord.

2. Loosen the screws on both sides of the Magnetic Disk Drive Module that hold the front panel in place. Gently slide the front panel forward.

3. The air filter is located inside the front panel. See Figure C.1a. Remove it by sliding it out from the top of the panel.

4. Vacuum the filter to remove accumulated dust and debris

5. Replace the filter in the front panel and re-attach the panel to the unit.

WARNING: DO NOT OPERATE THE MAGNETIC DISK DRIVE MODULE WITHOUT THIS FILTER.

C.2 INSPECT THE MAGNETIC DISK DRIVE MODULE FAN

This should be done at least every month. The fan is located in the center of the rear panel of the unit. If the fan is not turning, is turning very slowly, or is making noise, you will need to replace the entire module. See Sections 4.5, 4.6, and 4.7.

WARNING: DO NOT OPERATE THE UNIT IF THE FAN IS NOT WORKING PROPERLY. SEVERE COMPONENT DAMAGE MAY RESULT.

C.3 CLEAN THE OPTICAL DRIVE MODULE AIR FILTER

This should be done AT LEAST every six months, but, depending on site conditions, may be required more frequently.

1. At the right side of the Filter Grill, find the Filter Grill Latch. Push it to the right and hold it to release the grill for access to the air filter. See Figure C.1b.

2. Grasp the right side of the grill and pull it away from the latch.

3. Pull the left side of the grill free of the Filter Grill Retainer and remove the grill from the unit.

4. Remove the filter from the grill.

5. Clean the filter in lukewarm water, using a mild detergent.

6. Rinse the filter well and let it dry thoroughly.

7. Replace the filter in the grill.

8. Replace the Filter Grill in the optical drive.

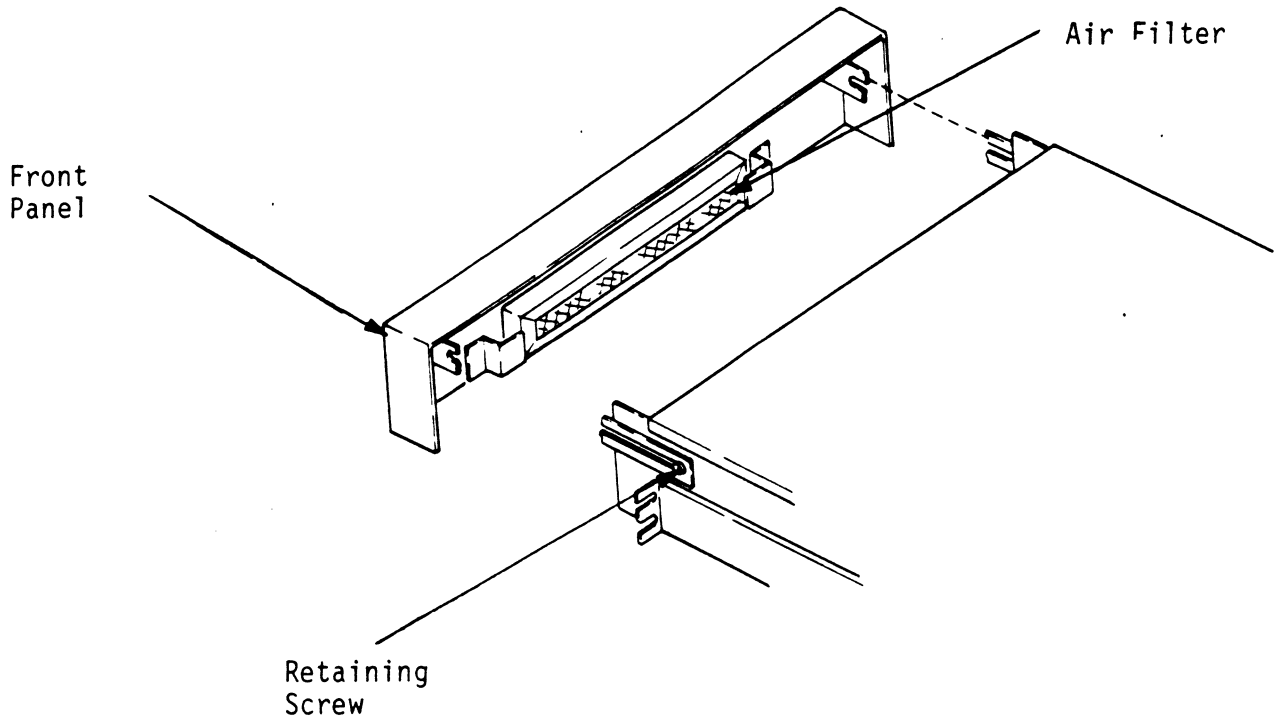
WARNING: DO NOT OPERATE THE LRS-10 WITHOUT THIS FILTER IN PLACE.

C.4 ADDITIONAL OPTICAL DRIVE MAINTENANCE CHECKS

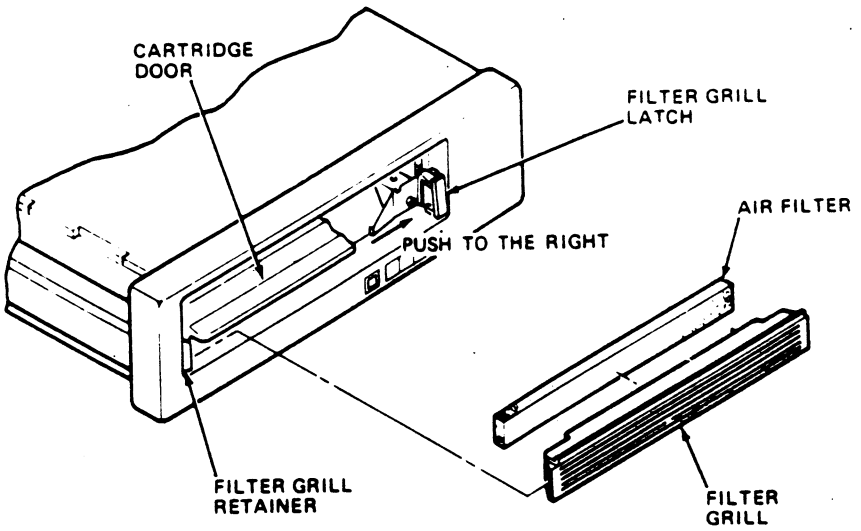
1. At least once a month, verify that the Cartridge Door Interlock is functioning properly. With power to the unit off, you should be unable to open the door. With power on (but the drive not spun up), the door should open easily.

2. Periodically inspect the entire unit visually to verify that no panels or doors are loose or distorted, as this may allow access to invisible laser radiation.

FIGURE C.1 Location of Magnetic Disk Drive Module and Optical Drive Module Air Filters



(a)



(b)

APPENDIX D

D.0 .IDEF PROGRAMMING PROCEDURE

The .IDEF system call allows the system to recognize interrupts from a device that was not originally SYSGEN'd. The procedure below must be strictly adhered to in order to successfully use it. The procedure is written based on the assumption that the reader is thoroughly familiar with DG I/O programming practice.

Note that none of the I/O instructions issued by the programmer actually invoke the secondary device. Instead, they are issued to the device code of the Optical Disk Controller. In the instructions below, "DSKP" stands for the Controller device code.

1. In the CLI, do INIT DPJx, then RELEASE DPJx. "x" is the number of your DPJ device.

2. In your working accumulator, place the following:

```
BIT:      0 1 2 3 4 5! 6 7 8 9 10 11 12 13 14 15
                      !
VALUE:    Alt Dev Cd ! 1 0 1 0  0  0  1  1  1  1

OCTAL:    xx1217
```

3. Issue: DOCS ACC, DSKP

4. Issue: DIC ACC, DSKP

5. Loop on the instruction in Step 4 until the value 65656 (oct) appears in the accumulator. When it does, the BUSY flip-flop will set.

6. Issue the command you want to send, in the following sequence:

```
DOA ACC, DSKP
DOB ACC, DSKP
DOC ACC, DSKP
```

   The DOC must come last, and must NOT contain a START. The command will begin executing immediately after the DOC is sent.

7. When execution is complete, the DONE flip-flop will set, BUSY will clear, and the CPU will receive an interrupt from the alternate device.

8. In your interrupt handler, when you issue a CLEAR to clear the interrupt it must be to DSKP.

You can issue as many commands as you wish to the alternate device, but FOR EACH COMMAND, YOU MUST DO THE ENTIRE SEQUENCE AGAIN, STARTING WITH STEP 2.

APPENDIX E

E.0 WRITE PROTECTION

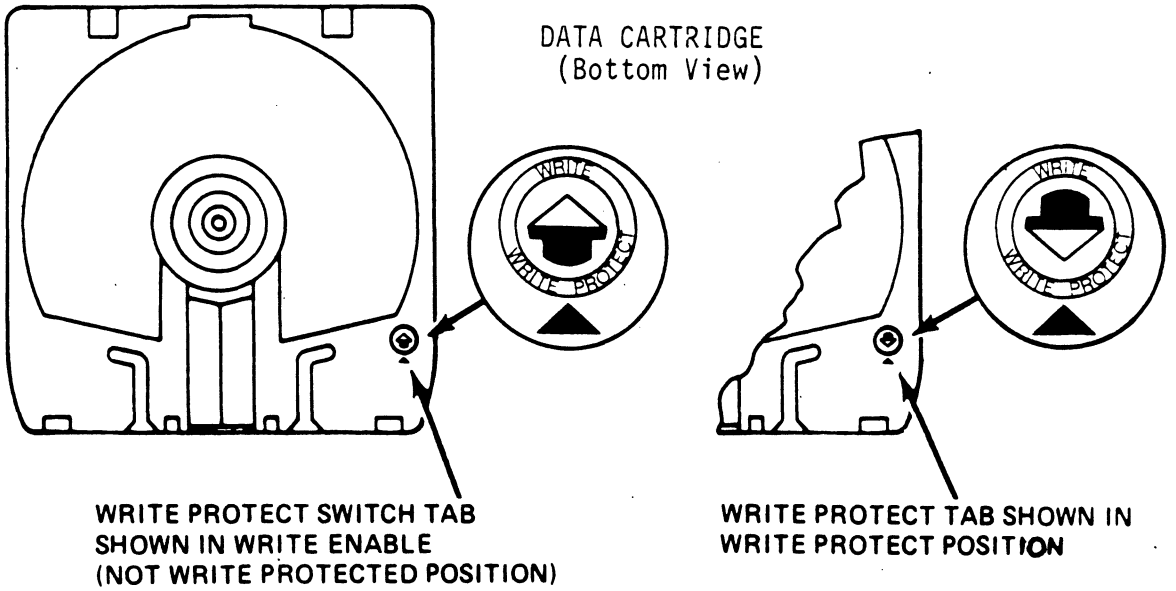
Since an optical platter is a Write-Once/Read-Many data storage medium, it is desirable to be able to prevent inadvertent writing to it. There are two ways to do this manually:

1. On the Data Cartridge there is a Write Protect Tab. When rotated to the proper position, write protection is enabled. See Figure E.1.

2. On the Optical Drive Module Operator Panel (see Figure 2.9) there is an alternate action WRITE PROTECT switch with an indicator imbedded in it. When pressed to the IN position, write protection is enabled.

You can use either method, or both at the same time. Note that the WRITE PROTECT indicator will be lit if either method is used.

FIGURE E.1 Data Cartridge Write Protect Tab



APPENDIX F

F.0 LED ERROR CODES

A complete discussion of the LEDs and their role in basic subsystem trouble-shooting is presented in Sections 4.1.4 and 4.2 of this manual. The tables below identify the specific test or error associated with each error code.

TABLE F.1 HOST Module Error Codes

CODE	TEST
1	RAM TEST
2	HI-SPEED BUFFER 1
3	HI-SPEED BUFFER 2
4	DONE
5	BURST COUNTER
6	BREAK COUNTER
7	BMC CB TEST
8	SECTOR TRANSFER SIMULATION
9	EEPROM CHECKSUM
10	DUAL PORT RAM
11	RESERVED
12	RESERVED
13	RESERVED
14	ERROR CONDITION

TABLE F.2 SCSI Module Error Codes

CODE	TEST
1	RESERVED
2	DYNAMIC RAM TEST
3	BMC DATA BUFFER
4	DUAL PORT RAM
5	5380 SCSI IC
6	DYNAMIC RAM PARITY
7	NOT USED
8	NOT USED

TABLE F.3 Operational Error Codes

CODE	ERROR
9	BMC DATA BUFFER PARITY ERROR
10	DYNAMIC RAM PARITY
11	ILLEGAL INTERRUPT FROM HOST SIDE
12	UNABLE TO ISSUE MODE SELECT TO OPTICAL DRIVE

G.0 THE MAINTENANCE PLATTER

Since optical platters are write-once media it is impractical to use them for random write testing. Furthermore, unless you know the data previously written to a platter, even read testing is limited. Nevertheless, it is desirable to be able to test the read and write functionality of your drives.

The solution is to dedicate a platter to read/write testing and manage it in such a way as to maintain strict control over its usage. We will call such a platter the Maintenance Platter.

The key to proper management of the Maintenance Platter is the Platter Log. This is actually a map of how the available space on the platter is used. We will allocate a certain portion to write testing and another portion to read testing. Each time we write data to the write area we will update the log to show the remaining space available for future writes. Precise segments of the read space will be further allocated to specific data patterns.

Table G.1 shows a sample Platter Log. The maximum number of usable logical disk blocks on this optical platter is 1958271 (dec). We chose to allocate approximately 50% to write space, 1% to small blocks of a variety of data patterns, and another 49% to larger blocks of the same patterns.

TABLE G.1 Sample Platter Log

	USED
WRITE SPACE: 0-979135	0 - 120203
SMALL READ PATTERNS: SIZE 2392 EACH	
0 LOGICAL BLOCKS	979136 - 981527
1 FLOATING ZERO	981528 - 983919
2 FLOATING ONE	983920 - 986311
3 ALTERNATE ZEROS (52525 OCT)	986312 - 988703
4 ALTERNATE ONES (125252 OCT)	988704 - 991095
5 ALL ZEROS	991096 - 993487
6 ALL ONES	993488 - 995879
7 ROTATING (125252 OCT)	995880 - 998271
LARGE READ PATTERNS: SIZE 120000 EACH	
0 LOGICAL BLOCKS	998272 - 1118271
1 FLOATING ZERO	1118272 - 1238271
2 FLOATING ONE	1238272 - 1358271
3 ALTERNATE ZEROS (52525 OCT)	1358272 - 1478271
4 ALTERNATE ONES (125252 OCT)	1478272 - 1598271
5 ALL ZEROS	1598272 - 1718271
6 ALL ONES	1718272 - 1838271
7 ROTATING (125252 OCT)	1838272 - 1958271

To create a Maintenance Platter, you MUST be in the Sequential execution mode, and the Controller must be in Maintenance Mode. The sample dialogue below will guide you in beginning to set up your platter.

```
TIMEOUT IF DEVICE DOES NOT RESPOND ([YES],NO):

     <cr>
ENABLE MAPPING (YES,[NO]);

     <cr>

EXECUTION MODE:
     [R]ANDOM RELIABILITY  [S]EQUENTIAL RELIABILITY
ENTER YOUR CHOICE [R]:

     S

     THIS CONTROLLER CAN BE RUN IN ONE OF TWO MODES.  THE
FIRST IS RUNTIME MODE.  IN THIS MODE THE CACHING SCHEME IS
USED AND THE MAGNETIC DRIVE CANNOT BE ACCESSED DIRECTLY.
ALSO, THE MICROCODE WILL BE READ FROM THE DISK SO IT MUST
HAVE BEEN INSTALLED ON THE DISK PREVIOUSLY.
```

THE SECOND MODE IS THE MAINTENANCE MODE. IN THIS MODE THE CACHING SCHEME IS NOT USED AND THE MAGNETIC CAN BE ACCESSED DIRECTLY. ALSO, THE MICROCODE MUST HAVE ALREADY BEEN DOWNLOADED ONTO THE CONTROLLER BY RUNNING THE "R" SELECTION IN THE UTILITY PROGRAM.

```
SHOULD THE CONTROLLER BE RUN IN THE RUNTIME MODE (YES,[NO]):

     <cr>

              LRS-10 RELIABILITY UTILITY
                     REV. X.XX

                   COMMAND LIST

[E]NTER A DEVICE              [D]ELETE A DEVICE
[S]TART A PROGRAM             [H]ALT A DEVICE
[R]ESTART THE PROGRAM         [L]IST ERROR TOTALS
[C]OMMAND LIST                [P]RINTER CONTROL
[Q]UIT                        [M]ODIFY DISPLAY MODE

ENTER A COMMAND SELECTION:

     M

THE DISPLAY MODES ARE:
     0 - OCTAL
     1 - DECIMAL
     2 - HEXADECIMAL

ENTER THE NUMBER OF YOUR CHOICE [0] (OCT):

     1
```

** We chose decimal because the Platter Log in Table G.1 is in decimal. **

```
ENTER A COMMAND SELECTION:

     E

ENTER THE DEVICE CODE [64] (OCT):

     <cr>

START INITIALIZATION OF CONTROLLER.

END INITIALIZATION OF CONTROLLER.
UNIT   0000   IS READY; SELECT (YES,[NO]):

     yes
```

THE SELECTED DISK IS AN OPTICAL DISK. YOU MAY WRITE (SEQ. REL I) AND READ TO THIS DISK, BUT YOU SHOULD NOT ATTEMPT TO WRITE TO THE SAME AREA ON THE DISK MORE THAN ONCE.

THE MINIMUM LOGICAL DISK BLOCK IS [0000] (OCT):

979136

** Refer to Table G.1. We are going to leave blocks 0-979135 blank for future writing, so at this point we designate the start of our first small read pattern. **

THE MAXIMUM LOGICAL DISK BLOCK IS [617577] (OCT):

981528

ON THE OPTICAL DISK IN MAINTENANCE MODE THE UPPER BLOCK ADDRESS MUST BE AN ODD NUMBER

THE MAXIMUM LOGICAL DISK BLOCK IS [617577] (OCT):

981527

** Since we previously decided each of these pattern spaces would be 2392 blocks, we first added 2392 to 979136 to get our maximum block. However, because of the way disk blocks are organized on the platter, the upper block MUST be an odd number. Therefore, we must add the number of blocks we want MINUS 1 (2392 - 1 = 2391). Now, 979136 + 2391 = 981527. The resulting number matches what is in our Platter Log. Note also that the lower block MUST be even. **

WRITE ONLY (YES, [NO]):

<cr>

** Since we are primarily concerned at this point with getting our data patterns out on the disk, we could have answered yes at this point. If we had, the next question would have been the verify question. **

READ ONLY (YES, [NO]):

<cr>
VERIFY DATA (YES,[NO]):

yes

** We do this to be sure that we are writing good data onto the platter. **

```
DATA TYPES
0-LOGICAL BLOCK ADDRESS      1-FLOATING ZERO
2-FLOATING ONE               3-ALTERNATE ZEROES (52525)
4-ALTERNATE ONES (125252)    5-ALL ZEROS
6-ALL ONES                   7-RANDOM (ONLY IN RANDOM REL I)
8-ROTATING (125252)          9-RUN ALL PATTERNS
SELECT DATA TYPE [0.] (DEC):

     <cr>

**  This is the first data pattern, according to our log.  **

UNIT 0 IS SELECTED

UNIT   0001   IS READY; SELECT (YES,[NO]):

     <cr>

UNIT   0002   IS READY; SELECT (YES,[NO]):

     <cr>

UNIT   0003   IS READY; SELECT (YES,[NO]):

     <cr>

              LRS-10 RELIABILITY UTILITY
                     REV. X.XX

                   COMMAND LIST

[E]NTER A DEVICE             [D]ELETE A DEVICE
[S]TART A PROGRAM            [H]ALT A DEVICE
[R]ESTART THE PROGRAM        [L]IST ERROR TOTALS
[C]OMMAND LIST               [P]RINTER CONTROL
[Q]UIT                       [M]ODIFY DISPLAY MODE

ENTER A COMMAND SELECTION:

     S

START ALL ENTERED DEVICES ([YES],NO):

     <cr>

**  After the operation is completed, a status list will be
displayed.  **
```

```
STATUS LIST: RUN TIME  0. HRS    0. MINS.
DEVICE CODE 24 UNIT NUMBER00 MAPPING NOT ENABLED STATE:HALTED
MODES: MAINTENANCE, SEQUENTIAL, READ/WRITE, DATA
CHECK-LOGICAL BLOCKS
BLOCKS WT  2392  BLOCKS RD  2392    TOTAL ERRORS          0
SEQUENTIAL RELIABILITY FINISHED ON THIS UNIT.
ENTER A COMMAND SELECTION:
```

** At this point we would select the "E" command again and write our next block of data onto the platter. Note that if for some reason you cannot write to a particular area of the disk (ie., you get disk errors), write the boundaries of the bad area down in your log, go on to write your patterns to a different area, and record its boundaries. **

After you have finished writing all your patterns, you may wish to try writing to the write space. Consider the follcwing example.

```
ENTER A COMMAND SELECTION:

     E

ENTER THE DEVICE CODE [64] (OCT):

     <cr>

START INITIALIZATION OF CONTROLLER.

END INITIALIZATION OF CONTROLLER.
UNIT   0000    IS READY; SELECT (YES,[NO]):

     yes

THE SELECTED DISK IS AN OPTICAL DISK.  YOU MAY WRITE (SEQ.
RELI) AND READ TO THIS DISK, BUT YOU SHOULD NOT ATTEMPT TO
WRITE TO THE SAME AREA ON THE DISK MORE THAN ONCE.

THE MINIMUM LOGICAL DISK BLOCK IS [0000] (OCT):

     120204
```

** Since we have already used blocks 0 - 120203, we specified the NEXT unused block. If we had inadvertantly entered 120203, we would have gotten an error when we tried to run the program. ON AN OPTICAL PLATTER, IN MAINTENANCE MODE, YOU CANNOT WRITE TO A BLOCK THAT HAS ALREADY BEEN WRITTEN TO. (In RUNTIME Mode this is masked by controller use of scrub space.) **

```
THE MAXIMUM LOGICAL DISK BLOCK IS [617577] (OCT):

     120303
```

** We decided to write 100 blocks. 100 - 1 = 99, which we added to our minimum block of 120204. **

```
WRITE ONLY (YES, [NO]):

     <cr>

READ ONLY (YES, [NO]):

     <cr>

VERIFY DATA (YES,[NO]):

     yes

DATA TYPES
0-LOGICAL BLOCK ADDRESS     1-FLOATING ZERO
2-FLOATING ONE              3-ALTERNATE ZEROES (52525)
4-ALTERNATE ONES (125252)   5-ALL ZEROS
6-ALL ONES                  7-RANDOM (ONLY IN RANDOM REL I)
8-ROTATING (125252)         9-RUN ALL PATTERNS
SELECT DATA TYPE [0.] (DEC):

     <cr>
```

** You can choose any pattern except 7 or 9. In Sequential Mode you cannot run random patterns. Do not run ALL patterns because this option will automatically go back and try to write the ne - pattern over the previous one. On an optical drive this w..l cause an error.

```
UNIT 0 IS SELECTED

UNIT   0001   IS READY; SELECT (YES,[NO]):

     <cr>


UNIT   0002   IS READY; SELECT (YES,[NO]):

     <cr>

UNIT   0003   IS READY; SELECT (YES,[NO]):

     <cr>
```

```
                    LRS-10 RELIABILITY UTILITY
                           REV. X.XX

                          COMMAND LIST

[E]NTER A DEVICE                    [D]ELETE A DEVICE
[S]TART A PROGRAM                   [H]ALT A DEVICE
[R]ESTART THE PROGRAM               [L]IST ERROR TOTALS
[C]OMMAND LIST                      [P]RINTER CONTROL
[Q]UIT                              [M]ODIFY DISPLAY MODE

ENTER A COMMAND SELECTION:

     S

START ALL ENTERED DEVICES ([YES],NO):

     <cr>

STATUS LIST: RUN TIME  0. HRS    0. MINS.
DEVICE CODE 24 UNIT NUMBER00 MAPPING NOT ENABLED STATE:HALTED
MODES: MAINTENANCE, SEQUENTIAL, READ/WRITE, DATA
CHECK-LOGICAL BLOCKS
BLOCKS WT   100  BLOCKS RD   100    TOTAL ERRORS          0
SEQUENTIAL RELIABILITY FINISHED ON THIS UNIT.
ENTER A COMMAND SELECTION:
```

Once you've completed your writing, be sure to update the write space portion of your log.

```
------------------------------ USED---------------
WRITE SPACE:  0-979135          0 - 120303
-------------------------------------------------
```

APPENDIX H

H.0 USER REFERENCE INFORMATION

This appendix contains reference for disk key layout, error code descriptions, parameter block layout and default values, plus a map of the magnetic and optical disk layout.

They are included to provide easy access to this information for interested users. Note that with these references and the recover program tools, a user may make a detailed examination of the LRS-10.

LRS-10 REV C DISK KEY REFERENCE
6/29/88

WORD (HEX)	DESCRIPTION
00	NUMBER OF WORDS TO CHECKSUM OVER (=B4H) (NOTE 1)
01 THRU 7E	COPY OF PARAMETER BLOCK WORDS 01 TO 7E (NOTE 2)
7F	KEY TYPE (NOTE 3)
80	PLATTER NUMBER LOWER
81	PLATTER NUMBER UPPER
82 THRU AC	UNUSED
AD	KEY BACKUP EVENT COUNTER
AE	CACHE TABLE BACKUP EVENT COUNTER
AF THRU B2	UNUSED
B3	KEY CHECKSUM
B4 THRU C7	UNIT STATUS INFORMATION USED BY CONTROLLER
C8 THRU E8	UNUSED
E9	DISK READY STATUS
EA THRU FF	UNUSED

NOTE 1: WORDS 00-AC OF THE MAGNETIC AND OPTICAL DISK KEYS MUST MATCH FOR AN "ACTIVE" SUBSYSTEM TO GO ONLINE.

NOTE 2: WORDS 1B-3A OF THE MAGNETIC DISK KEY AND CURRENT PARAMETER BLOCK MUST MATCH FOR AN "ACTIVE" SUBSYSTEM TO GO ONLINE.

NOTE 3: KEY TYPE DEFINITIONS:

HEX VALUE	STATE
A1	OFFLINE
A2	NEW
A3	EMPTY
A4	ACTIVE
A5	COMPLETE (OPTICAL KEY)
A6	PURGED (MAGNETIC KEY)
A7	ERROR

LRS-10 REV C CONTROLLER ERROR CODES
6/29/88

INITIALIZATION ERRORS:

ERROR CODE (HEX)	DESCRIPTION
000A	Configuration parameter block checksum error.
000F	Platter layout revision level in parameter block is less than 5; must be 5 or greater for controller compatibility.
0014	READ of magnetic disk key returned hard error on one or both copies.
0019	Magnetic disk key data failed checksum.
001E	Undefined magnetic disk key type.
0021	Magnetic disk key data does not compare with configuration parameter block information.
0023	READ of optical disk key returned hard error other than blank.
0028	Optical disk key data failed checksum.
002D	Undefined optical disk key type.
0032	Illegal magnetic and optical disk key type combination; either: A) Optical key new (blank) and magnetic neither new or empty, OR B) Optical neither new, active, complete or offline.
0037	Magnetic and optical disk key data does not compare; both are set to active state.

003C	Error reading cache table from magnetic disk at new platter INIT.
0041	Corrupted cache table read from magnetic disk at new platter INIT.
0046	Error backing up cache table copy #1 to magnetic disk.
0047	Error backing up cache table copy #2 to magnetic disk.
004B	Error backing up scrub directory copy #1 to magnetic disk.
004C	Error backing up scrub directory copy #2 to magnetic disk.
0050	Error reading system blocks from magnetic disk at new platter INIT.
0055	Error writing system blocks to cache at new platter INIT.
0057	Error writing optical disk keys at new platter INIT.
005A	Error writing magnetic disk keys at new platter INIT.
005F	Error reading cache table from magnetic disk for active platter.
0064	Error reading cache table copy #1 from magnetic disk.
0065	Error reading cache table copy #2 from magnetic disk.
0069	Cache table copy #1 header failed checksum.
006A	Cache table copy #2 header failed checksum.
006E	Cache table copy #1 head and tail do not compare.
006F	Cache table copy #2 head and tail do not compare.
0073	Hard error reading scrub directory from magnetic or opitcal disk.
0078	Scrub directory contains corrupted data; bad checksum or miscompare of scrub key with scrub event.
007D	Failed WRITEs of all copys or optical disk key.
0082	4 of 5 WRITEs of optical disk key failed.

ON-LINE ERRORS:

ERROR CODE (HEX)	DESCRIPTION
00D2	Request sense command to optical drive failed.
00D7	Received unused microprocessor interrupt.
00DC	BMC data buffer parity error.
00E1	Dynamic RAM parity error.
00E6	Hard system reset received while SCSI command busy.
00EB	Disk READ error.
00F0	Cache WRITE error.
00F5	Cache WRITE error during first sector concatenation.
00FA	Optical READ error during first sector concatenation.
00FF	Optical READ error during last sector concatenation.
0104	Cache WRITE error during last sector concatenation.
0109	Error moving data from cache to optical disk (rollout) following WRITE command.
010E	WRITE command to completed platter exceeded allowable block count.
0113	Illegal command sequence during WRITE command to completed platter.
0118	Error flushing data from cache to optical disk to make room for new WRITE data.
011D	Allowable scrub space size exceeded.
0122	Scrub directory full.
0127	Error writing magnetic disk key to error state.

PLATTER COMPLETION ERRORS:

ERROR CODE (HEX)	DESCRIPTION
0136	Platter complete attempted with cache disabled. Examine previous log entries for any initialization errors.
013B	Cache entry found containing error flags.
0140	Optical disk WRITE error; retrys expired.
0145	Cache READ error.
014A	Cache entry found containing error flags.
014F	Fatal optical disk WRITE error.
0154	Scrub directory/space full.
0159	Error writing "COMPLETE" optical disk keys.
015E	Error writing "COMPLETE" magnetic disk keys.
0163	Error writing scrub directory copy #1 to optical disk.
0164	Error writing copy #2.
0165	Error writing copy #3.
0172	All 3 copies of scrub directory written to optical disk failed.
0177	2 of 3 copies of scrub directory written to optical disk failed.
0186	Complete terminated with error flag set.

EXTENDED (OFF-LINE) COMMAND ERRORS:

ERROR CODE (HEX)	DESCRIPTION
019A	Error reading optical disk key in copy optical to magnetic keys command.
019F	Copy keys command attempted with optical disk not in active state.
01A4	Error writing magnetic disk key in re-activate/re-initialize magnetic disk key command.

LRS-10 REV C PARAMETER BLOCK LAYOUT, DEFAULT VALUES
6/29/88

LRS10 WORD	DEFAULT VALUE (HEX)	DESCRIPTION
00	0080	NUMBER OF WORDS TO CHECKSUM OVER
01 THRU 08	202020...	BOARD ID CODE, ASCII TEXT, FACTORY CONFIGURED
09 THRU 18	202020...	PLATTER ID CODE, ASCII TEXT, USER DEFINED
19	0001	BASE PLATTER NUMBER LOWER
1A	0000	BASE PLATTER NUMBER UPPER
-- NOTE 1 --		
1B	0005	PLATTER LAYOUT REVISION LEVEL
1C	0000	UNUSED
1D	0000	UNUSED
WORDS 1E-2F SPECIFY MAGNETIC DISK LAYOUT. VALUES REPRESENT 512 BYTE BLOCK PHYSICAL DISK ADDRESSES ON THE MAGNETIC DISK.		
1E	0024	SCSI MICROCODE DISK ADDRESS LOWER
1F	0000	" " " UPPER
20	004C	DKINIT BLOCKS DISK ADDRESS LOWER
21	0000	" " " UPPER
22	0080	MAGNETIC DISK KEYS ADDRESS LOWER
23	0000	" " UPPER
24	0082	SCRUB DIR COPY 1 DISK ADDRESS LOWER
25	0000	" " " UPPER
26	0182	CACHE TABLE COPY 1 DISK ADDRESS LOWER
27	0000	" " " UPPER
28	0386	CACHE SPACE DISK ADDRESS LOWER
29	0000	" " UPPER
2A	0386	UNUSED
2B	0002	UNUSED
2C	0400	MAINTENANCE TEST SPACE DISK ADDRESS LOWER
2D	0002	" " " UPPER
2E	5D9F	DISK ENDING ADDRESS LOWER
2F	0002	" " UPPER
WORDS 30-37 SPECIFY OPTICAL DISK LAYOUT. VALUES REPRESENT 1024-BYTE BLOCK PHYSICAL DISK ADDRESSES ON THE OPTICAL DISK.		
30	0000	UNUSED
31	0000	UNUSED
32	5380	SCRUB SPACE BASE DISK ADDRESS LOWER
33	000E	" " " UPPER
34	FF28	SCRUB DIR COPY 1 DISK ADDRESS LOWER
35	000E	" " " UPPER
36	FFFE	DISK ENDING ADDRESS LOWER
37	000E	" " UPPER
38	ABA8	SCRUB SPACE SIZE IN 1024 BYTE OPTICAL BLOCKS
39	0000	SEGMENTED OPTICAL DISK BASE ADDRESS LOWER
3A	0000	" " " UPPER

3B	0004	MAX NUMBER OF OPTICAL DRIVES ON SUBSYSTEM
3C	0000	NUMBER OF DKINIT BLOCKS
3D	005F	READ-LOOKAHEAD ENABLE SWITCH (5F=ON, A0=OFF)
3E	0400	UNUSED
3F	007C	WRITE QUEUE BUFFER SIZE
40	0001	MAX WRITE BLOCK COUNT ALLOWED FOR COMPLETED PLATTER
41	005F	UNUSED
42	7F5C	SCRUB SPACE MAX ENTRYS CUTBACK LEVEL (50%)
43	55D4	SCRUB SPACE SIZE CUTBACK LEVEL (50%)
44-6F	0000	UNUSED
70	0000	RESERVED
71	0000	RESERVED
72	0000	RESERVED
73-7E	0000	UNUSED
7F	A5BA	CHECKSUM

NOTE 1: WORDS 1B-3A OF THE MAGNETIC DISK KEY AND CURRENT PARAMETER BLOCK MUST MATCH FOR AN "ACTIVE" SUBSYSTEM TO GO ONLINE.

LRS-10 REV C DISK LAYOUT PARAMETERS 6/23/88
REFERENCED TO EEPROM WORDS

MAGNETIC DISK LAYOUT

LRS WORD / DEFAULT VALUE UPPER	LOWER	PARAMETER	SIZE (DEC) IN 512 BYTE BLOCKS
1D/0000	1C/0000	ARZ MICROCODE	36
1F/0000	1E/0024	SCSI MICROCODE	40
21/0000	20/004C	DKINIT SECTORS	8
0000	0054	UNUSED	20
0000	0068	EXECUTION LOG	8
0000	0070	ERROR LOG	8
0000	0078	UNUSED	8
23/0000	22/0080	MAGNETIC KEYS	2
25/0000	24/0082	SCRUB DIR COPY 1	128
0000	0102	SCRUB DIR COPY 2	128
27/0000	26/0182	CACHE TABLE COPY 1	258
0000	0284	CACHE TABLE COPY 2	258
29/0000	28/0386	CACHE SPACE	131072 (64MB)
0002	0385	LAST BLOCK USED	TOTAL = 131974 (67.6MB)
2B/0002	2A/0386	UNUSED	122
2D/0002	2C/0400	MAINTENANCE	23066
2F/0002	2E/5D9F	MAGNETIC END ADDR	TOTAL = 155040 (79.4MB)

OPTICAL DISK LAYOUT

LRS WORD / DEFAULT VALUE UPPER	LOWER	PARAMETER	SIZE (DEC) IN 1024 BYTE BLOCKS
(1024 BYTE BLOCK ADDRESS)			
31/0000	30/0000	UNUSED	
0000	0000	COMPLETE KEYS	5
0000	0005	ACTIVE KEYS	5
0000	000A	UNUSED	38
0000	0030	ERROR LOG COPY 1	4
0000	0034	ERROR LOG COPY 2	4
0000	0038	ERROR LOG COPY 3	4
0000	003C	UNUSED	4
0000	0040	SYSTEM SPACE	938816
33/000E	32/5380	SCRUB SPACE	43944
35/000E	34/FF28	SCRUB DIR COPY 1	64
000E	FF68	SCRUB DIR COPY 2	64
000E	FFA8	SCRUB DIR COPY 3	64
000E	FFE8	UNUSED	23
37/000E	36/FFFE	OPTICAL END ADDR	TOTAL = 983039 (1.00 GB)