

# Large Optical Disk Library

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## Service Manual

Part Number: EK-SS100-SV.B01

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## Preface

This manual assumes you are familiar with computer terms. It is divided into six chapters and three appendixes and is organized to allow you to quickly find the information that you need.

Here's what you'll find in this manual:

- Chapter 1 provides an introduction that lists the features and components, product configurations, and the characteristics of the drive mechanism and the disks for the RW514/RW516/RW534/RW536 Optical Library.
- Chapter 2 provides environmental, installation and preventive maintenance information on the RW514/RW516/RW534/RW536 Optical Library.
- Chapter 3 provides configuration and operating information on the RW514/RW516/RW534/RW536 Optical Library.
- Chapter 4 provides troubleshooting and diagnostics information on the RW514/RW516/RW534/RW536 Optical Library.
- Chapter 5 provides removal and replacement procedures for the field-replaceable assemblies in the RW514/RW516/RW534/RW536 Optical Library.
- Chapter 6 provides theory of operation information on the RW514/RW516/RW534/RW536 Optical Library.
- Appendix A provides a typical VAX system error report, SCSI-2 reference, and offline diagnostic information.
- Appendix B provides a list of parts and supplies.
- Appendix C provides instructions for installing the RW516-UA/RW536-UA capacity upgrade kit.

## Conventions Used in This Guide

**Table 1 Conventions Used in This Guide**

<b>Convention</b>	<b>Use</b>
<i>Italics</i>	<i>Italic text</i> is used for titles of manuals and other publications.
Monospace type	Anything that is displayed on the control panel of the Optical Library is set in monospace type like this.
<b>Boldface type</b>	<b>Anything that you are asked to type is set in boldface type like this.</b>
<code>Keys</code>	<code>Keys</code> indicate the key to press on the control panel of the Optical Library.
<b>Note</b>	A note calls attention to information which is helpful in understanding the operation of the product.
<b>CAUTION</b>	Caution notes provide information that protects your Optical Library from being damaged.
<b>WARNING</b>	Warning notes provide information that protects you from being harmed.

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# Introduction

## 1.1 The RW514/RW516/RW534/RW536 Optical Disk Library Overview

The RW514, 57.2 Gbytes and RW516, 93.6 Gbytes are large-capacity optical storage libraries.

The RW514 and RW516 both come with four 5.25-inch, 650 Mbyte multifunction optical drive mechanisms. Multifunction disk drives sense whether a rewritable or write-once disk was inserted and changes modes as appropriate. These libraries support both rewritable and write-once 512 bytes/sector optical disk cartridges.

The RW534/RW536 has approximately twice the storage capacity of the RW514 /516. This added capacity is due to a difference in the optical drives contained in the libraries. The RW534/RW536 contains a 1.3 Gbyte drive, an enhanced version of the 650 Mbyte drive that is used in the RW514/RW516 version libraries. The 1.3 Gbyte drive supports the use of 1.2 Gbyte disks as well as the 594 Mbyte disks that are supported for use with 650 Mbyte drives. Other than the added support of 1.2 Gbyte disks, the RW534/RW536 libraries are mechanically, electrically, and operationally the same as the RW514/RW516 libraries, and both versions support the SCSI-2 command set.

## 1.2 Product Features

These optical disk libraries, regardless of the capacity, have the following features and meet the following specifications:

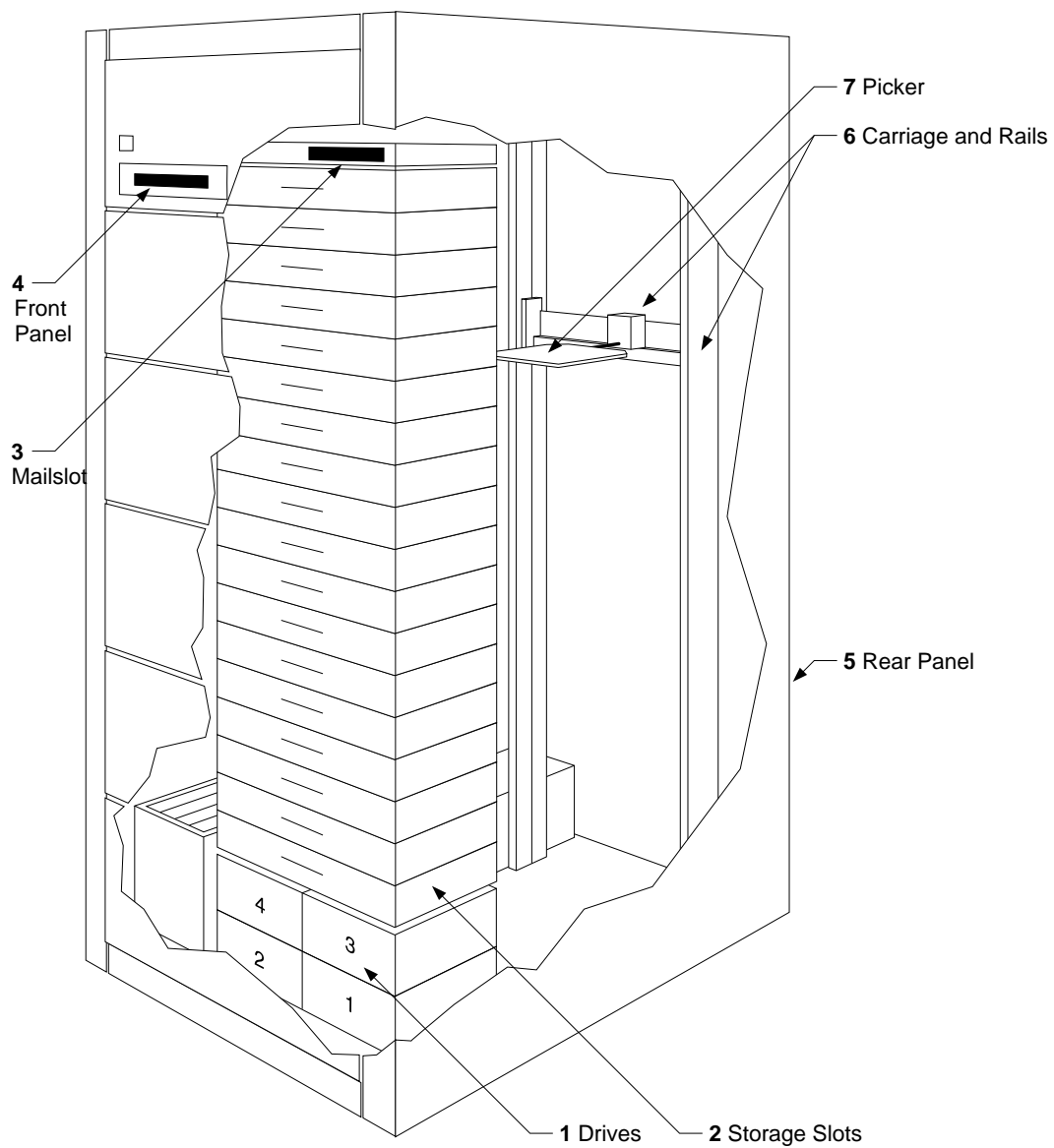
- direct online access to data
- greater security through the ability to "lock" the autochanger (prevent disk removal)
- high autochanger reliability through a design that eliminates the motors, cables, and sensors from the delivery mechanism

- autochanger reliability of:
  - 100,000 hours MTBF
  - 1,200,000 MSBF (Mean Swaps Between Failure)
- 8-second average disk exchange time (excluding the drive load/unload sequence)
- multifunction capability (write-once and rewritable technologies)
- high reliability and data security when using Digital-supplied rewritable and write-once 5.25-inch optical disks
- DEC rewritable optical disks meet ANSI and ISO standards for Continuous-Composite (CC) format. They conform to ISO/IEC DIS 10089A; ANSI X3.212-199x and the 1.2-Gbyte optical disk meets ECMA 184 standard for CC format.
- DEC write-once disks meet ISO and ANSI standards for Continuous-Composite - Write-Once format (CCW). They conform to ISO/IEC DIS 11560; ANSI X3.220-199x and the 1.2-Gbyte optical disk meets ECMA 184 standard for CCW format.

### **1.3 Product Components**

Refer to Figure 1–1 for an illustration of the RW514/RW516/RW534/RW536 Optical Library Components .

Figure 1-1 RW514/RW516/RW534/RW536 Optical Library Components



ZS-0661-MH

1. Disk drives                   The optical disk library contains four optical disk drives for read/write data transfer. Each drive requires a unique SCSI address.
2. Magazines                   The optical disk library contains either 11 or 18 magazines. Each magazine has 8 storage slots for a total of either 88 or 144 optical disk storage slots.
3. Mailslot                    The mailslot is used to insert and remove optical disks from the optical disk library.
4. Front panel                The front panel includes a control panel used to manage and display autochanger functions, and a slot to insert and remove disks.
5. Rear panel                 The rear panel includes SCSI, UPS and power cord connections. (Information on connecting the optical disk library to the host computer is given in the *Optical Library User's Guide*, EK-STSOP-UG.)
6. Carriage and rails        The carriage and rails support the picker for its movement within the optical disk library.
7. Picker                     The picker rotates, flips, and transports disks to and from storage slots, drives, and the mailslot.



### 1.3.1 Capacity Configurations

The RW514 has a maximum storage capacity of 57.2 Gbytes. This capacity is achieved through 11 magazines that each hold 8 disk cartridges which gives a total of 88 cartridges. The RW514 holds a 594-Mbyte cartridge (512bytes/sector) or, 297 Mbytes/side. The RW534 supports a maximum capacity of 114.4 Gbytes, whereby each cartridge holds 1.2 Gbytes.

RW516 has a maximum storage capacity of 93.6 Gbytes. This capacity is achieved through 18 magazines that each hold 8 disk cartridges of 594 Mbytes each (a total of 144 cartridges). The RW536 supports a maximum capacity of 187.2 Gbytes, whereby each cartridge holds 1.2 Gbytes.

The RW514/RW534 has the top seven magazines removed and a filler panel installed in their place. The Controller PCA for the RW514/RW534 works only with this 88-slot library.

Capacity differences in the above libraries are determined by the number of disks the library is capable of storing and the type of drives used in the library. The RW534/RW536 libraries contain “2x” drives, which are an enhanced version of the RW514/RW516 libraries. The drives in RW534/RW536 support the use of higher capacity (1.3-Gbyte) disks and have twice the buffer RAM (512 Kbytes) of the RW514/RW516 drives.

A RW514/RW534 may be converted into a RW516/RW536 through the RW516-UA/RW536-UA upgrade product kit (Appendix C). In the upgrade, the Controller PCA is changed to a new controller for a 144-slot version (RW516/RW536) and the filler panel is replaced with seven magazines.

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#### Note

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The firmware is the same for RW514/RW516/RW534/RW536. The firmware reads the type of controller it is installed into and configures itself accordingly.

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### 1.3.2 The Optical Drive Mechanism

The optical drive mechanism is a multifunction drive and, therefore, operates in both rewritable and write-once modes. The drive uses both rewritable and write-once 5.25-inch magneto-optical disks that comply with ANSI and ISO standards for Continuous Composite format. The drive senses the disk type and automatically operates in either rewritable or write-once mode.

The drive has a 3600 rpm rotational speed and can achieve a maximum sustained write transfer rate of 0.5 to 0.8 Mbytes per second and a maximum sustained read transfer rate of 1 to 1.6 Mbyte per second. The error rate is less than one block in error per  $10^{14}$  bytes, depending on the media and drive capacity.

Immediate response mode and write caching are used by the drive mechanism to achieve its high write performance. However, if a power failure occurs while write data is in the buffer, the drive may not have enough power to complete the write operation and empty the buffer. Therefore we recommend that an uninterruptable power supply (UPS) be used with battery backup to ensure that no data is lost if a power failure occurs.

### **1.3.3 Magneto-Optical Disks**

Magneto-Optical (MO) disks are more durable, more reliable, removable, and cost far less per megabyte than magnetic disks. MO disks are made of the same kind of plastic used in bullet-proof windows. Data can be read through fingerprints and minor scratches. MO disks can withstand x-rays, magnetic interference, and can be dropped from desk height without damage.

Magneto-Optical disks store data on a magnetic layer in the form of magnetic flux reversals rather than on a pitted surface used in other optical technologies. Because surfaces of the MO disk are not physically changed, they can be written to and erased repeatedly with no measurable data degradation. Optical disks have an archival life of thirty years based on accelerated life tests for data retention.

The disk is mounted in a rigid plastic case with a metal shutter, similar to a 3.5-inch magnetic flexible disk. Each optical disk holds 594 Mbytes of data, or 1.2 Gbytes of data, when 512 bytes per sector disks are used. (Check the host system documentation to determine which disk format is supported.) The MO disk has two recording sides. To access the second side, the cartridge must be ejected, turned over, and re-inserted into the drive.

There are two types of magneto-optical disks: rewritable optical disks and write-once optical disks. (Check the host system documentation to determine which disk type(s) are supported.) The two disk types can be differentiated by the words "rewritable" or "write-once" printed on the disk's metal shutter.

For data safety, you can independently write-protect each side of the disk by setting the write-protect tab on the corner of the cartridge.

## 1.4 SCSI Interface Options

The optical disk library connects to the host system through a Small Computer Systems Interface (SCSI). This interface conforms to SCSI standards ANSI X3.131-SCSI-2.

Usually each SCSI-connect peripheral requires one SCSI address. With the disk library, however, there are five unique SCSI interface addresses— one SCSI address for the autochanger controller and one for each drive contained in the disk library.

The autochanger controller and the host operating system manage communication through the SCSI bus to each drive's unique SCSI address.

The model RW514/RW516/RW534/RW536 is available with either a single-ended or differential SCSI interface. Initially only single-ended optical disk libraries will be available from Digital.

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### Note

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The interface type must be specified when ordering the library. Regardless of the type of external SCSI interface option chosen, the optical disk library internally uses SCSI single-ended signals and termination.

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### 1.4.1 Single-ended SCSI Interface

This option specifies a single-ended SCSI repeater PCA. This PCA enables the optical disk library to be connected to an external single-ended SCSI bus and also provides one other function; bus buffering. Bus buffering makes the library's internal SCSI bus length effectively zero and allows the use of the maximum single-ended SCSI external bus length of 6 meters for connection to the host system. (Actual library-to-host distance depends on whether there are any other SCSI devices on this bus).

### 1.4.2 Differential-ended SCSI Interface

This option specifies a differential SCSI repeater PCA. This PCA enables the library to be connected to an external differential SCSI bus. The differential SCSI repeater PCA uses the equivalent of 10 meters of SCSI cable internally, so the allowable external cable length is limited to 15 meters, instead of the 5 meters usually allowed on a differential SCSI bus.

## 1.5 Product Matrix

**Table 1–1 Optical Disk Library Product Matrix**

<b>Product No. /Options</b>	<b>Description</b>	<b>HP Designation</b>
RW514-ZF	A 57 gigabyte Optical Jukebox with a 88 disk slot capacity, one mail slot, four 650 Mbyte multifunction drives, one auto changer mechanism. Plus packaging, skid, ESD bag, and accessory kit. Single ended SCSI.	Model 60 (C1714C)
RW534-ZF	A 114 gigabyte Optical Jukebox with a 88 disk slot capacity, one mail slot, four 1.3 Gbyte multifunction drives, one auto changer mechanism. Plus packaging, skid, ESD bag, and accessory kit. Single ended SCSI.	Model 120T (C1714T)
RW516-ZF	A 94 gigabyte Optical Jukebox with a 144 disk slot capacity, one mail slot, four 650 Mbyte multifunction drives, one auto changer mechanism. Plus packaging, skid, ESD bag, and accessory kit. Single ended SCSI.	Model 100 (C1715C)
RW536-ZF	A 188 gigabyte Optical Jukebox with a 144 disk slot capacity, one mail slot, four 1.3 Gbyte multifunction drives, one auto changer mechanism. Plus packaging, skid, ESD bag, and accessory kit. Single ended SCSI.	Model 200T (C1715T)
RW516-UA	Slot upgrade kit only for RW514 to RW516. Consists of 56 slots, controller and hardware. Plus packaging, and ESD bag.	
RW536-UA	Slot upgrade kit only for RW534 to RW536. Consists of 56 slots, controller and hardware. Plus packaging, and ESD bag.	
RW536-UB	Converts 650 Mbyte multifunction drives to 1.3 Gbyte multifunction drives, to be used with either RW514 or RW516 jukeboxes. Consists of four 1.3 Gbyte drives, one RFI shield and cable kit, and the Installation Guide.	

## 1.6 Specifications

This section provides:

- Performance Specifications
- Physical Characteristics
- Environmental Specifications
- Power Requirements
- Service Characteristics
- Product Certification

**Table 1–2 Optical Disk Library System**

<b>Optical Disk Library</b>		
<b>Capacity</b>	88 disks, 57.2 Gbytes (RW514) 88 disks, 114.4 Gbytes (RW534) 144 disks, 93.6 Gbytes (RW516) 144 disks, 187.2 Gbytes (RW536)	
<b>Drives</b>	4 standard, 5.25-inch multifunction 650-Mbyte (RW514/RW516) or 1.3-Gbyte (RW534/RW536) optical drives	
Average disk exchange time (excluding drive load/unload sequences)	9 seconds	
Interface	Single-ended asynchronous SCSI	
<b>Multifunction Optical Drives</b>	<b>650 Mbytes (1x)</b>	<b>1.3 Gbytes (2x)</b>
<b>Seek times</b>		
Short stroke (across 2.2 Mbytes)	8 ms	4 ms
Average	25 ms	23.5 ms
Full stroke	50 ms	45 ms
<b>Average latency</b>	8.33 ms	8.33 ms
<b>Media load/unload time</b>		

(continued on next page)

**Table 1–2 (Cont.) Optical Disk Library System**

<b>Multifunction Optical Drives</b>	<b>650 Mbytes (1x)</b>	<b>1.3 Gbytes (2x)</b>
Load time (including spin up)	2.5 seconds (average)	2.3 seconds (average)
Unload time (including spin down)	2.0 seconds	1.4 seconds
<b>Data transfer rate * (512 bytes/sector)</b>		
Reads (maximum sustained)	1.0 Mbytes/second	.8-1.6 Mbytes/second
Writes (maximum sustained)	.5 Mbytes/second	.4-.8 Mbytes/second
Burst	5 Mbytes/second synchronous  3 Mbytes/second asynchronous	5 Mbytes/second synchronous  3 Mbytes/second asynchronous

\* System and application software dependent

<b>RW514/RW516/ RW534/RW536 Physical Characteristics</b>	<b>Rewritable</b>	<b>Write-once</b>
Disk	5.25 in. diameter (130 mm)	5.25 in. diameter (130 mm)
Capacity (512-byte sectors) (1x)	594 Mbytes (297 Mbytes/side) (formatted)	594 Mbytes (297 Mbytes/side) (formatted)
Capacity (512-byte sectors) (2x)	1.2 Gbytes (formatted)	1.2 Gbytes (formatted)
Format (1x)	Continuous Composite (CC) (ISO 10089)	CCW ISO 11560
Format (2x)	Continuous Composite (CC) (ISO 10089), ECMA 184 standard for CC format	CCW ISO 11560, ECMA 184 standard for CCW format

(continued on next page)

**Table 1–2 (Cont.) Optical Disk Library System**

<b>RW514/RW516/ RW534/RW536</b>		
<b>Physical Characteristics</b>	<b>Rewritable</b>	<b>Write-once</b>
Bytes per sector (1x)	512 (medium dependent)	512 (medium dependent)
Bytes per sector (2x)	512 (medium dependent)	512 (medium dependent)
Sectors per track (1x)	31 (medium dependent)	31 (medium dependent)
Sectors per track (2x)	31 (medium dependent)	31 (medium dependent)
Physical tracks per side (1x)	18751	18751
Physical tracks per side (2x)	21600	21600
Physical tracks per inch (1x)	15875	15875
Physical tracks per inch (2x)	18273	18273
Error Rate (1x)	Less than 1 block in error per $10^{14}$ bytes	Less than 1 block in error per $10^{14}$ bytes
Error Rate (2x)	Less than 1 block in error per $10^{14}$ bytes	Less than 1 block in error per $10^{14}$ bytes
Security	Write protect tab (1 per side)	Write protect tab (1 per side)
Medium archival life	30 years	30 years
<b>RW514/RW516/ RW534/RW536 Power Requirements</b>		
<b>Line Voltage</b>	100-127 VAC 200-240 VAC	
<b>Line Frequency</b>	50-60 Hz	
<b>Power Consumption (per library)</b>		
Maximum	475 Watts	
Typical	200 Watts	

**Table 1–3 RW514/RW516/RW534/RW536 Environmental Conditions**

	<b>Autochanger</b>	<b>Drives</b>	<b>Media</b>
<b>Temperature</b>			
Operating	10°C to 40°C	5°C to 50°C	10°C to 60°C
Non-operating	-40°C to 60°C	-40°C to 70°C	-10°C to 50°C
Temperature gradient	10°C per hour	10°C per hour	10°C per hour
Transportation (greater than 14 consecutive days)	-30°C to 60°C	-30°C to 60°C	
<b>Humidity (non-condensing)</b>			
Operating	10 to 90%	5 to 90%	10 to 80%
Non-operating	5 to 95%	5 to 95%	10 to 90%
Maximum wet bulb	29°C	29°C	29°C
<b>Shock (non-operating)</b>			
End-use, handling	10.2 cm tilt drop test, 4 edges		760 mm drop (to 2 mm vinyl-covered concrete)
Transportation (30 g trapezoidal)	427 cm/s	742 cm/s	
Operating, no data loss		10 g	
<b>Vibration (5-500 Hz range)</b>			
Operating (max. accel)	0.21 g rms	0.5 g rms	>0.21 g rms
Non-operating			
Random	2.09 g rms	3 g rms	
Swept Sine	0.5 g 0-peak	1 g 0-peak	
<b>Altitude</b>			
Operating	4,572 m (15,000 ft)		

(continued on next page)



**Table 1–3 (Cont.) RW514/RW516/RW534/RW536 Environmental Conditions**

	Autochanger	Drives	Media
Non-operating	15,240 m (50,000 ft)		
<b>Acoustic Emissions (A-weighted sound power)</b>			
Power-on, standby	6.0 bels		
Operating	6.5 bels		

**Table 1–4 RW514/RW516/RW534/RW536 Physical Characteristics**

	Library System	Ground Packaging	Air Packaging
<b>Dimensions:</b>			
Height	1847 mm (72.7 in.)	1854.2 mm (73.0 in.)	2082.8 mm (82.0 in.)
Width	651.2 mm (25.6 in.)	658.8 mm (27.0 in.)	914.4 mm (36.0 in.)
Depth	971.4 mm (38.2 in.)	1041.4 mm (41.0 in.)	1219.2 mm (48.0 in.)
<b>Weight:</b>			
w/o disks	360.0 kg (792 lbs)	375.5 kg (826 lbs)	409.0 kg (900 lbs)
with disks	392.0 kg (864 lbs)	407.5 kg (898 lbs)	441.0 kg (972 lbs)

**Table 1–5 RW514/RW516/RW534/RW536 Service Characteristics**

<b>Parameter</b>	<b>Description</b>
Mean time between failure	100,000 power-on hours
Mean swaps between failure	1,200,000
Mean time to repair	1 hour
Preventive maintenance	none required

**Table 1–6 RW514/RW516/RW534/RW536 Product Certifications**

<b>Parameter</b>	<b>Description</b>
Safety	UL 1950 listed and recognized CSA C22.2 No. 950-M89 IEC 950 TUV approved to VDE 0805 (EN 60950)
Electromagnetic Emissions	FCC 47 CFR Part 15 Subpart J - Level "A" FTZ 1046/84 - Level "B" EN 55022/CISPR 22 Level A-SABS
Laser	CDRH 21 CFR Chapter 1, Subpart J, Registered TUV approved to VBG 93, VDE 0837 TSH Approved to Decision 472 (C1705A only) BS 4803 Part 2 (complies) IEC 825
United Kingdom	The HP C1704C, C1705C, C1714C, C1715C are approved under Approval Number NS/G/1234/J/100003 for indirect connection to Public Telecommunication Systems within the United Kingdom.

## 1.7 Related Documents

**Table 1–7 Related Documents**

<b>Document Title</b>	<b>Part Number</b>
<i>Optical Library Conversion Kit Installation Guide</i>	EK-OLCON-IG
<i>Optical Library User's Guide</i> (shipped with each unit)	EK-STSOP-UG
<i>Optical Storage Desktop Software Installation Guide</i>	AA-PXYKA-TE
<i>Optical Storage Desktop Software User's Guide</i>	AA-PXYLA-TE
<i>Optical Storage Management Software Installation Guide</i>	AA-PXYPA-TE
<i>Optical Storage Management Software Installation Guide</i>	AA-PXYQA-TE
<i>Storage Server 100 Installation Guide</i>	EK-D59SS-IN
<i>Small Optical Disk Library Service Manual</i>	EK-SOL10-SV
<i>Medium Optical Disk Library Service Manual</i>	EK-MOL20-SV
<i>Storage Server 100 Optical Disk Service Manual</i>	EK-STSOP-SV‡
<i>Optical Disk Library System Technical Reference Manual</i> †	5959-3559 (GSD)
<i>Technical Guide, Optical Drives and Libraries</i> †	5960-7605
<i>Optical Drive and Library SCSI-2 Command Reference</i> †	5960-7606
<i>Offline Diagnostics for HP Optical Products</i> †	5960-7626

†These documents can be ordered directly from Hewlett-Packard

‡Only for older model 10/20 Jukebox shipped with (Ninja) storage server systems

**Table 1–8 Pass Documents**

<b>Pass</b>	<b>Entry Number</b>
RW5xx Hardware Pass	7174
Ninja Hardware Pass	6060
Optical Storage Management Software Pass	3731
Optical Storage Desktop Software Pass	3750

# 2

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## Environmental/Installation/PM

This chapter provides the procedures for optical library installation.

### 2.1 Environmental Requirements

The following environmental requirements should be met at each site before installation.

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**Note**

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The environmental specifications listed here apply when the disk library is not connected to a system. When this device is connected to host systems, the more stringent environmental specifications listed for any single device within the host system are applicable and supersede these specifications.

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#### 2.1.1 Operating Temperature/Clearance Requirements

The disk library is designed to operate with an ambient air temperature range of 10° to 40°C (50 to 104°F) with a rate of temperature change not to exceed 10°C (50°F) per hour.

The area does not have to be air-conditioned but maintaining an operating room temperature between 18°C to 24°C (65°F to 75°F) is recommended.

A minimum of 2-3 inches (70-80 mm) should be maintained behind the rear cover of the cabinet to allow air circulation.

## 2.2 Location Requirements

Position the drive away from sources of particulate contamination such as frequently-used doors and walkways, stacks of supplies that collect dust, and smoke-filled rooms. If possible, allow enough room behind the drive for access to the rear panel and for service.

Required Site Survey/Verification site survey is required because of the weight of this product.

This product includes one hour of site preparation and one-half hour for site verification.

See the next section for an explanation of the weight-bearing requirements.

### 2.2.1 Weight Bearing Requirements

The weight-bearing rating on computer room raised floors may be as low as 100 pounds per square foot. The RW514/RW516/RW534/RW536 could reach a maximum of 130 pounds/square foot when fully loaded with disks. Therefore, to install this product, the floor rating must meet or exceed 130 pounds per square foot.

The unit should be located as close to a tile corner post as possible. The tiles beneath and surrounding the unit should be solid. Special air-conditioning tiles are not needed near the unit.

## 2.3 Primary Power/External Ground

The female power outlet to be used to supply AC power to the autochanger must be checked to ensure that the proper voltage is available for the autochanger.

**Table 2-1 Acceptable Voltage/Frequency**

Voltage (Nominal)	Frequency (Nominal)	Voltage Range	Frequency Range
100 ±10%	50 ±10%	90-110	47-53
230 ±10%	50 ±10%	207-253	47-53
120 ±10%	60 ±10%	108-132	57-63
220 ±10%	60 ±5%	198-242	57-63

Also check the earth (safety) ground in the power outlet.

## 2.4 Installation Procedures

This section provides information on:

- Contents of shipment
- Uncrating and installing the RW514/RW516/RW534/RW536 Optical Libraries

Setting up the optical disk library is the customer's responsibility; however this service may be contracted for on a time-and-materials basis. Setup instructions for the disk library are in the *Optical Library User's Guide*, part number EK-STSOP-UG, which is shipped with the product.

The installation and configuration instructions are provided for situations where the customer has arranged for this service.

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### Note

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Before you connect the optical disk library to the host, verify that it is supported by the host. Refer to the Product Support Plan for the most current list of host systems which support RW514/RW516/RW534/RW536.

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### 2.4.1 Contents of Shipment

The contents will vary depending on which unit you receive but you should receive a crate containing the optical library, and a box, shipped separately, labeled **OPEN FIRST**. Inside this box are several additional packages containing the following:

- READ ME FIRST instructions
- The *Optical Library User's Guide*
- SCSI cable
- SCSI terminator
- Power cord

In addition to these items, to complete the installation you may need two wrenches—a 1/2 inch wrench and a 9/16 inch wrench—and a TORX T10, T15, T20, and T25 screwdriver (the blade is star-shaped) as well as wire cutters or a knife.

## 2.4.2 Uncrating the Large (RW514/RW516/RW534/RW536) Optical Library

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### CAUTION

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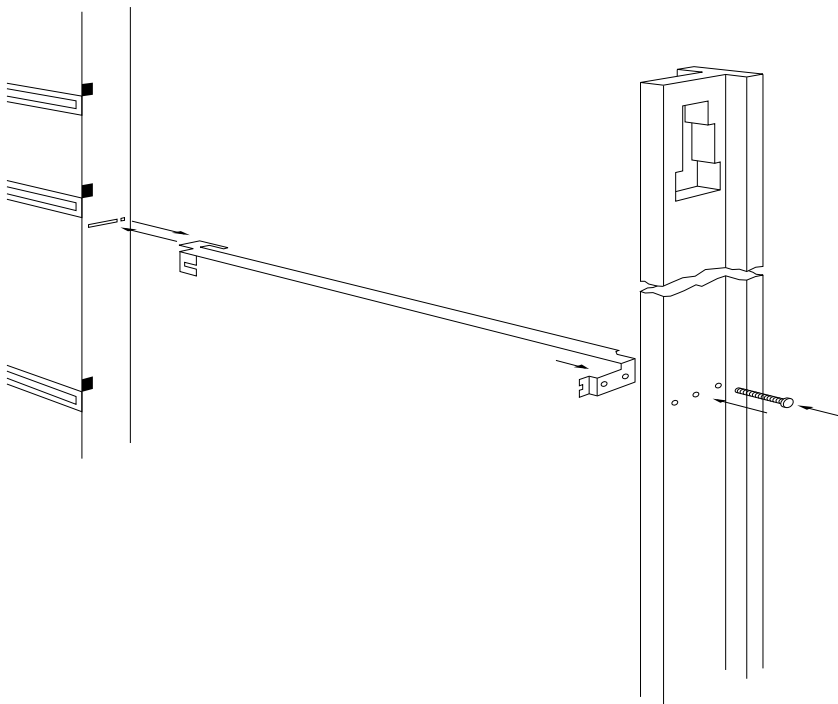
Two people are required to move the Optical Library Unit.

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1. Remove packaging Materials
2. Roll the unit into position.
3. Move the shipping bracket into "operation mode" position to allow free movement of the picker as follows: (Refer to Figure 2-1 for clarification of these steps.)



**Figure 2-1 Moving the Shipping Bracket into Operation Mode (Large Unit RW514/RW516/RW534/RW536)**



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- a. Unlock and open the rear cabinet door.
- b. Find the picker and the bright orange shipping bracket that secures it, located halfway up the rail on the right side of the Autochanger.
- c. Remove the screw that secures the shipping bracket using a Torx T-15 driver.
- d. Remove the shipping bracket from the picker by first pushing the bracket back to free the end of the picker farthest away from you. Swing the other end of the bracket to the right to free the end of the picker closest to you.

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**Note**

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Once released, the picker will glide slowly downward inside the Autochanger until the fingers are extended to a point where they catch on the magazines.

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- e. Push the shipping bracket as far as possible into the slot in the rail farthest away from you.
- f. Slide the bracket to the right and then pull it toward you so that the finger on the bracket protrudes out of the hole just to the left of the slot. (See Figure 2-1.)
- g. Insert the peg on the other end of the bracket into the center hole in the rail closest to you.
- h. Insert the screw (removed earlier) into the right-most hole in the rail and tighten.

The picker is now secured into the right-most position. This allows the picker to move freely along the rails and carriage.

4. Shut and lock the rear cabinet door.

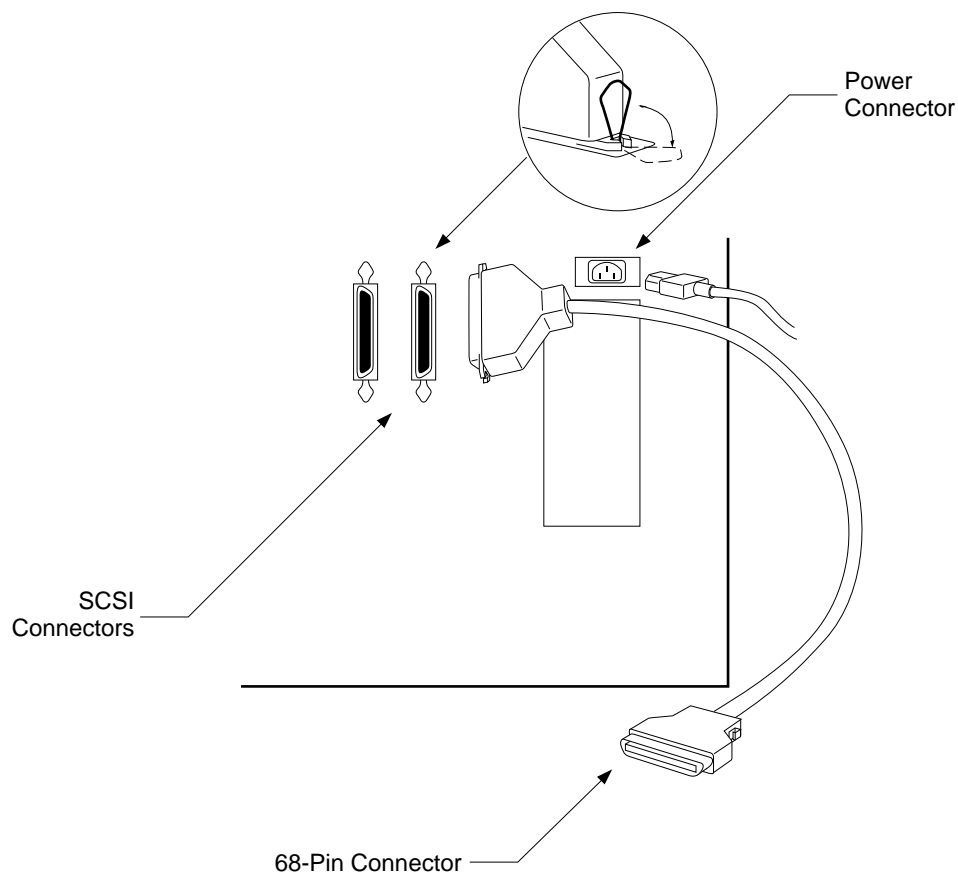
### **2.4.3 Installing the Optical Library**

#### **Attaching the SCSI Cable, SCSI Terminator, and Power Cord**

To attach the SCSI cable, SCSI terminator, and the power cord. See Figure 2-2 and follow these steps:

1. Locate the SCSI cable and SCSI terminator.
2. Locate the two SCSI ports on the rear of the machine. Plug the 50-pin Champ connector end of the SCSI cable into either port. The 50-pin Champ end is the one housed in plastic. (The other end is a metal connector with 50 pins and is labeled Honda.) The 50-pin Champ connector is keyed so that it only attaches one way. Lock the wire brackets into the grooves on the sides of the connector.

**Figure 2-2 Attaching the SCSI Cable and Power Cord (Large Unit RW514 /RW516/RW534/RW536)**



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3. Plug the SCSI terminator into the other SCSI port.

**Note**

The terminator must remain plugged into the second SCSI port on the back of the optical library.

4. Leave the 50-pin Honda end of the SCSI cable disconnected for now. Instructions for connecting this end to your host computer may be found in the host system documentation.

5. Locate the power cord. Locate the yellow safety sticker covering the power plug on the rear of the optical library. Pull the sticker away and plug in the power cord.
6. Remove the clamp from the rear panel using a Torx T-10 driver. Attach the clamp to the power cord approximately 4 to 5 inches from the end of the power cord plugged into the optical library. Reattach the clamp.
7. Plug the other end of the power cord into an electrical outlet.

### **Enable Operation**

To enable operation of the optical library follow these steps:

1. Close the rear cover of the optical library.
2. Position the optical library.
3. Press the white operation switch on the front of the optical library to enable operation of the optical library system.
4. The message **TESTING** is displayed, and the Drive 1, Drive 2, Drive 3 and Drive 4 lights are illuminated briefly, indicating the start of self-test. After about a minute, all the lights on the front panel are illuminated briefly for a lamp check, the current Rev # is displayed, and finally the **READY** message is displayed, indicating successful completion of the self-test. If the self-test fails, call your service representative.

Your optical library is now installed.

## **2.5 Hardware Verification**

The Customer Engineer needs to verify that the optical disk library is fully functional. To do this, the CE powers up the unit, which will invoke the poweron diagnostic. After completion of the poweron diagnostic, the CE should run internal diagnostics and test the autochanger mechanism and drive(s) to verify that all functions of the optical library unit (moves, flips, reads, writes, etc.) are operating correctly. Execute Tests 2 and 11 through 17 to accomplish final verification (refer to Section 4.11). Verify the library and drive IDs before connecting the other end of the SCSI cable to the host system to avoid bus conflicts (refer to Section 3.2). Refer to the host configuration guide to complete the installation.

## 2.6 Moving the Optical Disk Library

If you want to move the RW514/RW516/RW534/RW536 short distance, such as to another office or to another floor in your building, see Section 2.6.1. If you want to move the library a long distance or ship the optical disk library, see Section 2.6.2.

### 2.6.1 Moving the Optical Disk Library a Short Distance

For short moves, follow these steps:

1. Unmount (unreserve) any disk surfaces from the host system, if necessary.
2. Eject all disks from the optical disk library and, if the disks were not labeled with a storage slot location prior to inserting them into the optical disk library, do it now.

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**CAUTION**

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Failure to eject the disks from the optical disk library prior to transport could result in damage to the library mechanism.

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**CAUTION**

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See Section 2.2.1 before relocating the optical disk library.

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**CAUTION**

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Do not press the optical disk library operation switch to standby or unplug the AC power cord until you are sure that the SCSI bus is inactive. Either selecting standby mode on the operation switch or unplugging the power cord when the SCSI bus is active can cause data loss and/or indeterminate bus states. (Check the host system reference manuals for information on checking the status of the SCSI bus.)

Opening the rear cabinet door automatically removes power to the optical disk library motors. When the rear cabinet door is open, disks that are already in a drive can be read; however, if the host issues an autochanger command to access disks not currently in a drive, an error condition, or host "hang" results.

---

3. Switch off the optical disk library.

4. Remove the power cord and SCSI cable connections from the optical disk library
5. Raise the leveler feet using a 1/2-inch open-end wrench.
6. Carefully roll the optical disk library to its new destination.
7. Connect the optical disk library to the host.
8. Re-connect the power cord.
9. Lower the leveler feet using a 1/2-inch open-end wrench.

### 2.6.2 Moving the Optical Disk Library a Long Distance

To move the optical disk library a significant distance, or if it must be shipped, follow these steps.

1. Unmount (unreserve) any disk surfaces from the host system, if necessary.
2. Eject all disks from the optical disk library and, if the disks were not labeled with a storage slot location prior to inserting them into the optical disk library, do it now.

---

**CAUTION**

---

Failure to eject all disks from the optical disk library prior to transport could result in damage to the library.

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3. Run TEST 23 to position the picker for shipping.
  - a. Press **[OPTION]**.
  - b. Press **[NEXT]** until TEST \* appears, and then press **[ENTER]**.
  - c. Press **[NEXT]** until TEST 23 appears, and then press **[ENTER]**.
4. Position the optical disk library so that the rear panel is accessible and the rear cabinet door can be opened.
5. Unlock and open the rear cabinet door.
6. Locate the bright orange shipping bracket located halfway up the rail on the right side of the optical disk library.
7. Move the shipping bracket from its "operation mode" position ("A" in Figure 2-3) to its shipping position ("B" in Figure 2-3) by following these steps.
  - a. Remove the screw that secures the shipping latch using a Torx® T-15 driver.

- b. Move the end of the shipping bracket labeled "C" in Figure 2-3, from position "A" to position "B." (Detail "C" in Figure 2-3 is shown in Figure 2-4.)
  - c. Attach the slot in the shipping bracket to the end of the picker that is farthest away from you.
  - d. Insert the peg on the other end of the shipping bracket into the left-most hole in the rail and pull the bracket tight against the rail.
  - e. Verify that the circular cut-out in the shipping bracket fits around the protrusion on the carriage-end of the picker (adjust if necessary).
  - f. Insert the screw that was removed earlier into the hole indicated in Figure 2-3.
8. Shut and lock the cabinet rear door.
  9. Remove the power cable and SCSI cable connections from the optical disk library.
  10. Have the unit repackaged and shipped in the same manner in which it was received.

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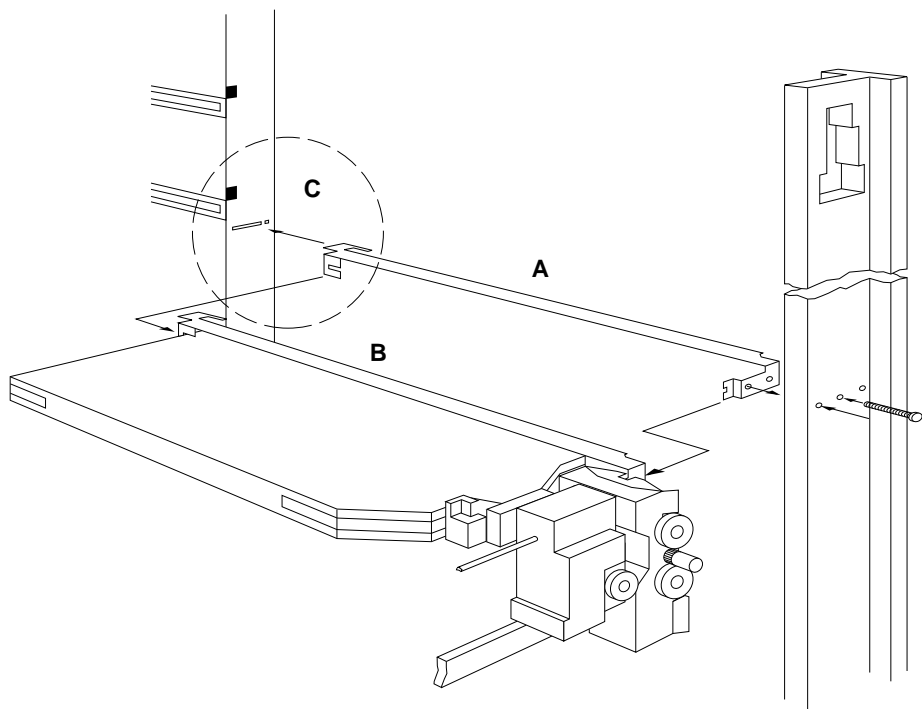
**CAUTION**

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See Section 2.2.1 in this section before relocating this optical disk library.

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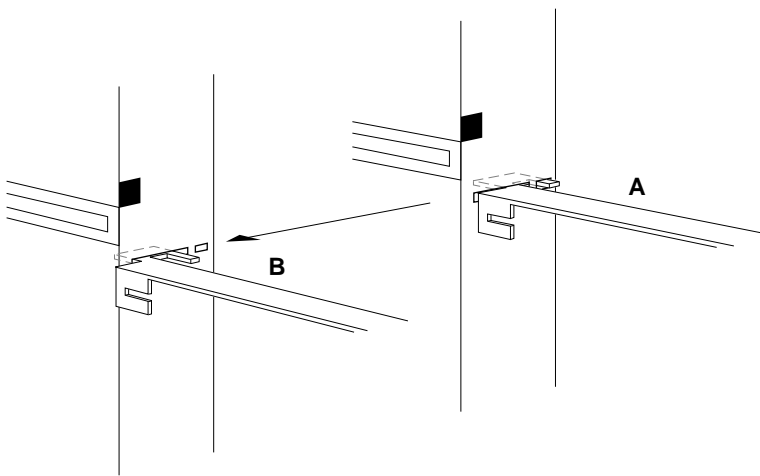
**Figure 2-3 Positioning the Shipping Bracket**



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**Figure 2-4 Shipping Bracket Detail**



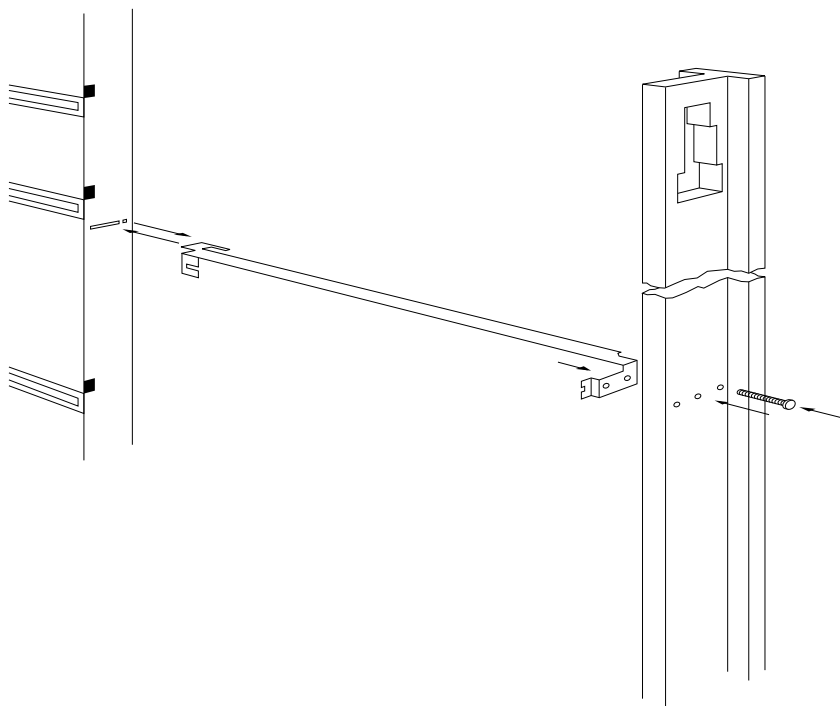
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Before powering on the optical disk library once it has reached its destination, move the shipping bracket back to the "operation mode" position to allow free movement of the picker. To move the shipping bracket to the operation mode position follow these steps:

(Refer to Figure 2-5 for clarification of these steps.)

1. Unlock and open the rear cabinet door.
2. Find the picker and the bright orange shipping bracket that secures it, located halfway up the rail on the right side of the autochanger.
3. Remove the screw that secures the shipping bracket using a Torx T-15 driver.
4. Remove the shipping bracket from the picker by first pushing the bracket back to free the end of the picker farthest away from you. Swing the other end of the bracket to the right to free the end of the picker closest to you.

**Figure 2-5 Installing the Shipping Bracket**



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**Note**

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Once released, the picker glides slowly downward inside the autochanger and the fingers extend. The fingers extend to a point where they catch on the magazine stack.

---

5. Secure the shipping bracket in its right-most position, which allows the picker to move freely along the rails and carriage.
  - a. Push the shipping bracket as far as possible into the slot in the rail farthest away from you.
  - b. Slide the bracket to the right and then pull it toward you so that the finger on the bracket protrudes out of the hole just to the left of the slot. (See Figure 2-4.)

- c. Insert the peg on the other end of the bracket into the center hole in the rail closest to you.
  - d. Insert the screw (removed earlier) into the right-most hole in the rail and tighten.
6. Shut and lock the rear cabinet door.
  7. Connect the power cable to the optical disk library. Connect one end of a SCSI cable to the optical disk library, and connect the other end to the host system.

## 2.7 Preventative Maintenance

There is no preventive maintenance for the optical disk library, however the optical disks may require cleaning.

Cleaning an optical disk is needed more commonly on standalone drives than with autochangers because of the differences in their environments and usage. Although an autochanger may be used in such a way as to make disk cleaning necessary, it is not recommended.

To determine whether or not disk cleaning is appropriate for your customer's situation, see "Optical Disk Cleaning" in Chapter 4.

---

### CAUTION

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Do not attempt to clean the optical drive objective lens! Although disk drive cleaning kits are available, they are not approved for use with the Model RW514/RW516/RW534/RW536. Using these kits to clean the drive in these libraries will damage the optical drive mechanism.

---

## 2.8 Service Recommendations

Since distributor system connects and operating systems are different from site to site, it is recommended that Digital Services personnel disconnect the RW514/RW516/RW534/RW536 from the host system and run internal self-tests from the front panel.

Internal self-tests are described in Section 4.10.2. There are also offline PC-based diagnostics (see Appendix A) which can be ordered.

---

**Note**

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Once the RW514/RW516/RW534/RW536 is disconnected from the host, and passes all internal selftests, the functionality of the RW514/RW516/RW534/RW536 may be considered verified.

Refer to the RW5xx Hardware Pass Entry 7174 for further details on support strategy.

---

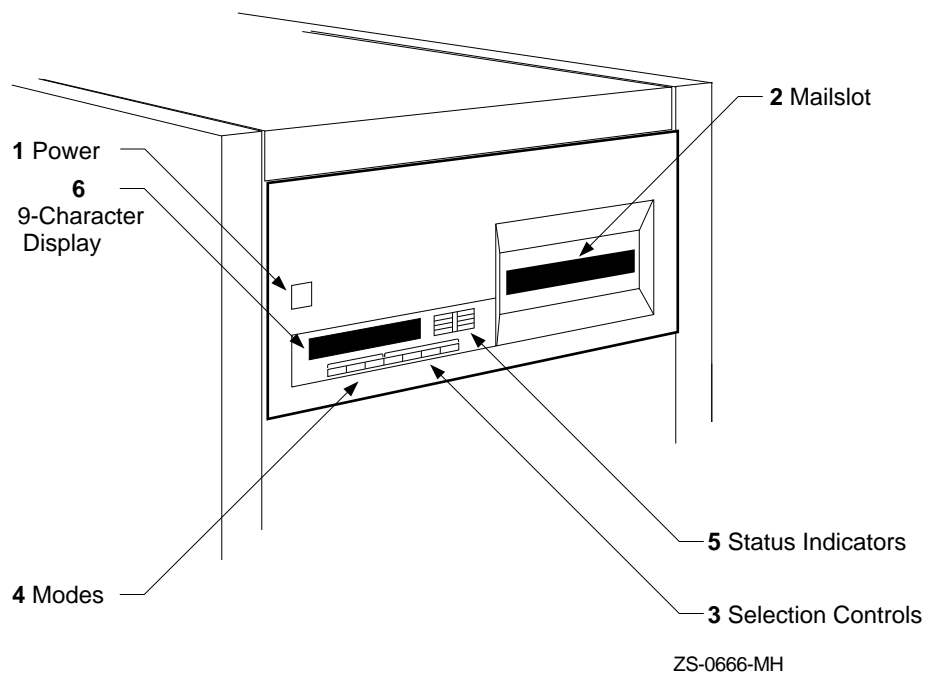
# 3

## Product Configuration and Operation

### 3.1 Front Panel and Control Panel Operations

Refer to Figure 3-1 for a view of the Optical Disk Library front panel.

Figure 3-1 Optical Disk Library Front Panel



1.     **Operation Switch**           Pushed to enable or disable operation of the optical disk library. This is not a power switch. Power is applied by inserting the AC power cord.
2.     **Mailslot**                 Used to insert or remove disks.
3.     **Status Indicators**       Lit when the indicated activity is taking place.
4.     **Selection Control**        Pressed to perform these operations:
  - CANCEL** cancels the current operation or choice.
  - PREV** scrolls the display choice backward by one.
  - NEXT** scrolls the display choice forward by one.
  - ENTER** chooses the displayed selection.
5.     **Mode Buttons**           Pressed to perform the desired operation.
  - LOAD** is pressed after you place the disk in the mailslot. Once **LOAD** is pressed, the display prompts you for the desired destination inside the unit. Once you choose the location, press **ENTER**. The disk loads to that location.
  - EJECT** is pressed to remove a disk from storage in the library. Once **EJECT** is pressed, the display prompts you for which disk location to eject. Once you choose the location, press **ENTER**. The disk is then brought from that location to the mailslot.
  - OPTION** is pressed to display the current operation options available such as TEST, INFORMATION, CONFIGURATION, and SCSI ID.
6.     **9-Character Display Window**   Displays information about the current operation. Generally you press **NEXT** or **PREV** to control the selections. Once your selection is displayed, you press **ENTER**. You may press **CANCEL** to cancel your selection.

### 3.1.1 Control Panel Tips

- Pressing **OPTION** a second time returns the optical disk library display to the READY state. The **OPTION** key acts like a toggle.
- Pressing **CANCEL** takes you back one step each time it is pressed.
- When selecting a number on the display, you can usually get to your selection three different ways:
  - Press **NEXT** or **PREV** to increment/decrement by one.
  - Hold **NEXT** or **PREV** down to increment/decrement by one at an accelerated speed.

- Press **EJECT** or **LOAD** to increment/decrement respectively by tens.

For example, if one of the numbers in your password is 167, you could press **NEXT** to get to that number. You could press **PREV** to work backwards to that number. Or you could press **EJECT** or **LOAD** to work forward or backward to the nearest ten (160 or 170) of that number and then press **NEXT** or **PREV** to get the exact number.

---

**Note**

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Using the **LOAD** and **EJECT** buttons to increment the display numbers by tens won't work if you are loading or ejecting disks.

---

## 3.2 Setting the SCSI Address

The optical disk library uses five SCSI addresses: one for each of the drives, and one for the autochanger. All of these addresses are set through the control panel. The default address settings are as follows:

Autochanger Controller - Address 5  
Optical Disk Drive #1 - Address 1  
Optical Disk Drive #2 - Address 2  
Optical Disk Drive #3 - Address 3  
Optical Disk Drive #4 - Address 4

If you want to change one or all of the addresses, follow these steps

1. Switch on the optical disk library if it is not already on.
2. With **READY** displayed, press **OPTION**. **TEST \*** displays. If **TEST \*** does not display, press **NEXT** until it does.
3. Press **NEXT**. **CONF \*** displays.
4. Press **NEXT**. **INFO \*** displays.
5. Press **NEXT**. **SCSI IDs \*** displays.
6. Press **ENTER**. **AC ID with a blinking ##** displays. The **##** is the autochanger controller address. If you want to change this address, press **ENTER**, otherwise continue to press **NEXT** until the drive number address that you want to change is displayed, (DRV1 ID 1, DRV2 ID 2, etc.)
7. Press **NEXT** or **PREV** until the address you want displays.
8. Press **ENTER**. The address you chose is now set.

9. If you want to change additional drive addresses, press **NEXT** until that drive number is displayed, press **ENTER**, and repeat steps 7 through 9 to set the new address.
10. Press **NEXT** until **UPDATE** or **CONFLICT** displays.
11. If **CONFLICT** displays, two or more drives and/or the controller have been set to the same address and must be reset.
12. If **UPDATE** displays and you are satisfied with the addresses you have selected, press **ENTER**.
13. Record the new address setting(s) for future reference.

---

**CAUTION**

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Do not remove power to the optical disk library until you are sure that the SCSI bus is inactive. Removing power from a SCSI peripheral when the bus is active can cause data loss and/or indeterminate bus states. (Check the host system reference manuals for information on checking the status of the SCSI bus.)

Opening the rear cabinet door automatically removes power to the optical optical disk library motors. When the rear cabinet door is open, disks that are already in a drive can be read; however, if the host issues an autochanger command to access a disks not currently in a drive, an error condition, or host "hang" will result.

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14. Power cycle the optical disk library so the new address setting(s) will be recognized by the host system.

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**Note**

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Power may have to be cycled on some host systems for the new address settings to be recognized.

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### 3.3 Setting a Configuration (CONF)

There are several ways the operations of the optical disk library can be customized. This customization can be done by setting configurations. A list of configurations that can be changed is given in Section 3.6.

More specific information on setting security configurations (CONF #15, 17, 20, 31 and 32) is given in Section 3.4.



Follow these steps to change a configuration:

1. With READY displayed, press **[OPTION]**. TEST \* displays.
2. Press **[NEXT]**. CONF \* displays.
3. Press **[ENTER]**. CONF 0 displays.
4. Press **[NEXT]** or **[PREV]** until CONF ## displays (where ## is the configuration number you want to change.)
5. Press **[ENTER]**.
6. Some configurations require a password. If prompted, enter the password.
7. Press **[NEXT]** or **[PREV]** until the value you want appears in the display.
8. Press **[ENTER]** once your choice displays. SET ## displays followed by CONF \*.

### 3.4 Securing the Optical Disk Library

In its default condition, the optical disk library is unsecured. Any user can insert or remove disks or access control panel displays, configurations, or tests. In an open environment, some precautions should be taken to secure access to the control panel, as well as to the following:

- sensitive data stored on optical disk surfaces
- configuration settings
- diagnostic log information

If the customer is concerned about security consider the following procedures:

- Set a new optical disk library password periodically and limit the number of people who know the password.
- Implement security configurations 15 and 20 which restrict disk insertion and removal.
- Keep the rear cabinet door locked; use the circular keys provided with the optical disk library. (These keys are the same for all libraries but limit casual access.)
- Use a padlock in the area provided on the lower left of the rear door.
- Locate the optical disk library in a physically secure environment.

### 3.4.1 Setting a Security Code

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**Note**

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This procedure is explained in the *Optical Library User's Guide* (EK-STSOP-UG). It is presented here as information to service personnel and in case the customer prefers this level of guidance as you set up the optical disk library.

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**Note**

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The default factory set security code is 0-0-0. When setting a new security code you must first key in the old security code (or default one, 0-0-0, if none has been set) and then key in the new security code.

The customer should key in the old security code and new security code during this procedure.

---

1. With READY displayed, press **[OPTION]**. TEST \* displays.
2. Press **[NEXT]**. CONF \* displays.
3. Press **[ENTER]**. CONF 0 displays.
4. Press **[NEXT]** until CONF 17 displays.
5. Press **[ENTER]**. 0 displays.
6. Enter the current security code (or the default security code, 0-0-0).
  - a. Press **[NEXT]** or **[PREV]** until first number of old (or default) security code displays.
  - b. Press **[ENTER]**. 0 displays.
  - c. Press **[NEXT]** or **[PREV]** until second number of old (or default) security code displays.
  - d. Press **[ENTER]**. 0 displays.
  - e. Press **[NEXT]** or **[PREV]** until third number of old (or default) security code displays.

- f. Press **ENTER**.

---

**Note**

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If the security code was keyed in successfully, the display prompts you for the new one. If a mistake was made in keying in the security code, NO CONFIG briefly displays and the unit returns to the CONF 17 display.

If you realize you've made a mistake in keying in a security code, press **CANCEL** to return to the CONF 17 option.

---

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**Note**

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It is a good idea for the user to write down the new security code prior to entering it into the optical disk library.

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7. Enter a new security code (user)
  - a. Press **ENTER**. A displays.
  - b. Press **NEXT** or **PREV** until first number of new security code displays.
  - c. Press **ENTER**. B displays.
  - d. Press **NEXT** or **PREV** until second number of new security code displays.
  - e. Press **ENTER**. C displays.
  - f. Press **NEXT** or **PREV** until third number of new security code displays.
  - g. Press **ENTER**. SET 17 displays.

### 3.4.2 Restricting Disk Insertion and Removal

Configurations 15 and 20 act together to control disks during normal and powerfail conditions.

- CONF 15 - when this is set to ON, you cannot insert or remove disks without a security code.
- CONF 20 - when this is set to ON, the CONF 15 status is maintained when a power fail occurs. Also, the reserved status on mounted surfaces is maintained if the autochanger power fails.

When setting CONF 15 or CONF 20, the display prompts you for a security code. This security code is 0-0-0 (default) or the one set by the customer using CONF 17.

Follow these steps to set CONF 15 or CONF 20.

1. Press **NEXT** or **PREV** until CONF 15 or CONF 20 displays.
2. Press **ENTER**. 0 displays.
3. Press **NEXT** or **PREV** until the first security code number displays.
4. Press **ENTER**. 0 displays.
5. Press **NEXT** or **PREV** until the second security code number displays.
6. Press **ENTER**. 0 displays.
7. Press **NEXT**, or **PREV** until the third security code number displays.
8. Press **ENTER**.
9. Press **NEXT** or **PREV** to select ON or OFF.
10. Press **ENTER**. SET 15 or SET 20 displays.

### 3.4.3 Controlling Mailslot Rotation

Configurations 31 and 32 allow control of mailslot rotation as described below. (See Section 3.3.)

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#### Note

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In its default state, the optical disk library's mailslot stays open, ready to accept an optical disk

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- CONF 31 - when this is set to ON and CONF 15 is also set to ON, the mailslot's default position is closed. The mailslot cannot be opened and disks cannot be inserted or removed until CONF 15, (requires a security code be set), is set to OFF. Setting this configuration to ON makes it visible to the user that the mailslot cannot be used until security configuration 15 is switched OFF.  
If the optical disk library is full, the mailslot opens only for an eject command.
- CONF 32 - when this is set to ON, the mailslot can be rotated open or closed from the control panel or it allows the host to control mailslot rotation using a SCSI rotate mailslot command. Pressing **OPTION** on the optical disk library's control panel displays an OPEN MS or CLOSE MS message. When the open or close message displays, press **ENTER** to toggle the mailslot open or closed.  
If the optical disk library is full, the OPEN/CLOSE MS is not displayed and the mailslot opens only for an eject command.

## 3.5 Host Configuration

Once the disk library is connected to the host system and the device address is set, you are ready to prepare the host system to access the library. To determine if the host you are connecting to supports the optical disk library and for further installation information, check the following documents:

- product support plan (available from your local Sales Support Office)
- host system documentation

## 3.6 Autochanger Configuration Choices

The following table lists the available configurations choices. An explanation of how to access and set these configurations is found in Section 3.3.

**Table 3–1 Autochanger Configuration Choices**

No.	Function	Default	Options
0	Clear/Save Error Log (Information Log 0)	Save	Clear - clears the error log immediately. Save - saves the error log until Clear is configured.
8	No Break on Failure	Off	Off - if a test encounters a failure, the test stops. On - if a test encounters a failure, the test continues.
10	Clear/Save Move Log (Information Log 10)	Save	Clear - clears the move log immediately. Save - saves the move log until Clear is configured.
11	Clear/Save Runtime Log (Information Log 11)	Save	Clear - clears the runtime log immediately. Save - saves the runtime log until clear is configured.
	<b>Configurations 15 - 20 require a security code.</b>		
15	Prevent Media Removal (security code required)	Off	On = No mailslot I/O Off = Normal mailslot I/O

(continued on next page)

**Table 3–1 (Cont.) Autochanger Configuration Choices**

No.	Function	Default	Options
16	Set Default Configurations (security code required)	Save	Clear - restores default configurations immediately. Save - maintains all set configurations.
17	Set New Security Code (security code required)	0-0-0	
18	Clear/Save Logs (security code required)  Clears/zeros these logs:  #4 - Drive Load Count #5 - Poweron Hours #9 - Move #12 - Flip #13 - Translate #14 - Mailslot Rotation	Save	Clear - clears/zeros the specified logs. Save - maintains the specified logs until clear is configured.
19	Set Autochanger Retries A - Max. attempts to find home B - Max. attempts to do move C - Max. attempts to restore move after failure.	4 2 1	Sets the number of attempts to retry moves before giving up.
20	Poweron Cartridge Security (security code required)	Off	On - maintains the status of configuration 15 upon power cycle or power failure. Off - Configuration 15 is not maintained through a power cycle or power failure.
21	Enable Autochanger Retries	On	On - Autochanger attempts to correct itself when it encounters difficulty. Off - Autochanger does not attempt to correct itself when it encounters difficulty.
22	Clear Drive 1 Load Count Log (Information Log 4)	Save	Clear - clears the Drive 1 Load Count Log immediately. Save - saves the Drive 1 Load Count Log until clear is configured.
23	Same as config. 22 for Drive 2.		

(continued on next page)

**Table 3–1 (Cont.) Autochanger Configuration Choices**

No.	Function	Default	Options
27	Report Recovered Error	Off	On - reports the SCSI-level error to the host. Off - no reports of SCSI-level errors to the host.
31	Secured Mailslot Rotation (security code required)	Off	Off - Normal mailslot operation. On - The mailslot rotates in when configuration 15 is set to ON or a Prevent Media Removal command is received. The mailslot remains closed until configuration 15 is set to OFF or an Allow Media Removal command is received. If the autochanger is full, the mailslot will open only for an EJECT command.
32	Mailslot Rotation Command (security code required)	Off	Off - Normal mailslot operation. If the host sends a Rotate mailslot command and config. 32 is set to off, the host will receive a Check Condition followed by a Sense Key of Illegal Request. On - When a Rotate Mailslot command is received (either from the host or via the control panel), the mailslot is toggled open or closed.
40	DEC/OEM Mode	Off	Off - Changes inquiry mode to DEC mode. Required when connected to a DEC computer to ensure integrity. This changes default of Autocontroller PCA. On - For use with OEM computers (HP).
41	DEC/OEM Mode	Off	Off - Changes inquiry mode to DEC mode. Required when connected to a DEC computer to ensure integrity. This changes default of 1.3 Gbyte multifunction drive only. On - For use with OEM computers (HP).

(continued on next page)

**Table 3–1 (Cont.) Autochanger Configuration Choices**

No.	Function	Default	Options
50	Emulate Model 60C or 120T Must be a Model 100C or 200T. Security code required	Off	Off - Normal Model 100C or 200T mode. (All 144 storage slots are available.) On - Emulates a Model 60C or 120T. Reduces the number of available storage slots from 144 to 88. This is only used for system integration, and should not normally be used.
66	Zero all RAM	Save	Save - RAM remains unchanged. Clear - Zeros all RAM locations and reboots. <b>Caution</b> - When this configuration is set to "Clear," the product ID and the vendor ID are cleared. This procedure is NOT RECOMMENDED.



# 4

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## Troubleshooting and Diagnostics

This chapter is divided into the following sections:

- **Operation/Installation Error Information**  
Lists common problems encountered during operation and installation of the optical disk library, and gives suggestions for solving these problems (top-level troubleshooting).
- **Control Panel Error Information**  
Provides error messages and log information which are available through the front panel display. This level of troubleshooting is used when hard or repeatable errors are encountered (intermediate-level troubleshooting).
- **Error Information through SCSI Commands**  
Error messages and log information available by issuing SCSI commands via a PC-based external host computer. This level of troubleshooting is used when soft or intermittent errors are encountered (in-depth troubleshooting).
- **Internal Diagnostic Utilities**  
Information about the available internal diagnostics used to aid in the troubleshooting process.

## 4.1 Operation/Installation Error Information

The following table lists problems that may occur during operation of the optical disk library. If you cannot find a solution to a problem in this section, go to the next section for more in-depth troubleshooting.

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### CAUTION

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DO NOT CYCLE POWER during any troubleshooting until you are sure the system SCSI bus is INACTIVE and will REMAIN INACTIVE.

Removing power while the bus is active can cause data loss and/or indeterminate bus states. Check the host system reference manuals for information on checking the status of the SCSI bus.

---

Task	Problem/Symptom	What to Do
Communicating to host library	Can't get host to recognize the optical disk library	<p>Check to make sure the optical disk library was installed and configured as described in the Chapter 2 and the appropriate host configuration guide.</p> <p>Check the SCSI connections.</p> <p>Check the SCSI interface address as it relates to the device files.</p> <p>Make sure SCSI IDs of Jukebox and MF drives do not conflict with other SCSI devices on the bus.</p> <p>Make sure software license was correctly installed.</p> <p>Make sure CONFIG 40 is set to DEC mode. Reference Section 3.3 and Section 3.6</p>
Changing drive addresses	Changed drive addresses but new address is not recognized	<p>After changing an address, the optical disk library power must be cycled for the address to be recognized. The host system may also have to be cycled for the address to be recognized.</p>

Task	Problem/Symptom	What to Do
Inputting security code	Security Code forgotten or misplaced for the optical disk library	First, try the default security code (0-0-0). If the default security code is not accepted, locate the four dip switches in the center of the controller PCA. Set switch 1 to "ON." Power on the optical disk library. Set switch 1 back to "OFF." Set a new security code.
Loading disks	Disk inserted in mailslot, but the display reads EMPTY or MISLOAD.	Press <b>CANCEL</b> and try inserting the disk in the mailslot again. Push the disk all the way in.
Powering On	Optical disk library won't power on.	Check to make sure the power cord connections are tight. Check to make sure the power outlet is operating. Replace the fuse with a new one. Replace the power cord. Replace the power supply module.
	Power-on self-test fails	Turn the unit off, then turn it on again. Observe the power-on test result. If the unit continues to fail, use the error code to begin troubleshooting.
	Does not boot correctly.	Make sure the boot disk is ON, spun up, and ready before applying power to the host computer. The autochanger and the host may then be powered on in any order.
Power fail	Just the optical disk library power fails.	When power returns, unmount and remount all disk surfaces. Do not eject any disks until the surfaces are unmounted/unreserved.
	Host computer power fails and the optical disk library stays on.	After the host reboots, file system check any write-mounted surfaces.
	Both the host system and optical disk library power fail.	After the host reboots, file system check any write-mounted surfaces. See the previous CAUTION note.

Task	Problem/Symptom	What to Do
Reading the front panel	No display messages appear.	<ul style="list-style-type: none"> <li>Check power cord connected.</li> <li>Check AC input.</li> <li>Check control panel cable connections.</li> <li>Replace control panel PCA.</li> <li>Replace AC controller PCA.</li> <li>Replace power supply module.</li> </ul>
Reading/writing optical disks	Can't write to the disk.	<ul style="list-style-type: none"> <li>Check the host file system access permissions.</li> <li>Check the write-protect tab on each disk side to assure write-enabled status.</li> <li>Check to make sure the disk was initialized.</li> <li>Check that the disk file system was mounted correctly.</li> <li>Check your application software.</li> </ul>

---

**CAUTION**

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Do not eject disks from the autochanger until all mounted surfaces are unmounted.

To prevent disks from being removed after a power failure, set Configuration 20 (Poweron Cartridge Security) to "ON." See Chapter 3 for an explanation of Configuration 20 and how it is set.

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**CAUTION**

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**DO NOT CYCLE POWER** during any troubleshooting until you are sure the system SCSI bus is **INACTIVE** and will **REMAIN INACTIVE**.

Removing power while the bus is active can cause data loss and/or indeterminate bus states. Check the host system reference manuals for information on checking the status of the SCSI bus.

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Task	Problem/Symptom	What to Do
Removing Disks	Disk removal attempted, but the storage slot or drive location won't display the option.	Make sure the optical disk surface's file systems have been unmounted.
	Disk removal attempted, but a FULL, MISLOAD, or RESERVE message displays.	Remove the disk from the mailslot and try to remove the desired disk again. If MISLOAD still displays, it could indicate a drive failure.  In the case of RESERVE, a security code was set to prevent disk removal. See Table 3-1, Autochanger Configuration Choices, number 15.
	The unit's power failed while a disk was in the drive.	Try powering on the unit. If successful, use the file system check command.  If power-on is unsuccessful, power the unit off. !!Do not move the unit!! Moving the unit with a disk in the drive risks damaging the magneto-optical mechanism in the MO drive. Refer to "Powering On" earlier in this table.

## 4.2 Power-on Self-test

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### CAUTION

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When the optical disk library is powered on and the self test is run, the SCSI interface and the terminator must both be either connected or disconnected.

If the controller senses that the optical drive is not connected to a host system via the SCSI interface, additional selftests are run on the SCSI circuitry. If these tests run while a terminator is attached, voltage levels at the SCSI bus connector are different than expected and a self test failure results.

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---

**CAUTION**

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Do not switch off any peripheral on the SCSI bus without first checking that the bus is not active.

Switching off can cause data loss and/or indeterminate bus states.

---

To run the power-on self test, perform the following steps:

1. Insert a formatted disk into the drive either from a storage slot location or through the mailslot/control panel.
2. Remove power from the optical disk library. Press both the power switch on the back panel and the operation switch on the front panel.
3. Remove the disk library top cover and side panels so that you can observe the LEDs on the front of the optical drive mechanism.

Follow the steps in Section 5.4.1, Service Access.

4. Switch on both the rear panel power switch and the front panel operation switch, and wait for the power-on self test to complete.

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**Note**

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A failure will occur under the following circumstances:

- if an UNFORMATTED disk is used during the test
  - if the host is not powered up and properly terminated
  - if the host is not connected and the drive is not correctly terminated.
- 

The power-on self test will have one of the following results:

Indication	Description	Further Diagnosis
The busy and the fault LEDs turn off.	No failure has occurred.	
The fault LED remains lit.	A failure had occurred.	Connect the offline diagnostic tool to determine failure.
The LEDs do not light at all, and the disk does not load.	There are possible loose power connections.	Check all power connections for the drives.

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## 4.3 Optical Disk Cleaning

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### Note

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Cleaning an optical disk is needed more commonly on standalone drives than with autochangers because of the differences in their environments and usage. While the following information is therefore more applicable to standalone drives, an autochanger may be used in such a way as to make the following cleaning information apply. Disk cleaning for libraries in general, however, is **NOT RECOMMENDED** as a normal user task.

---

Disk cleaning should only be done after a read/write failure or if a customer notices a loss of autochanger performance. In addition, it must be determined that the failure or loss of performance was not caused by a definite hardware failure.

A failure to read a disk may result from:

- hardware failure
- contamination of the disk surface
- contamination of the drive objective lens

On an otherwise working drive, check to see that the most current firmware code level is being used and/or that all applicable service notes have been done. If so, contamination could be a cause and cleaning may be necessary.

In the case of a read failure, cleaning might be the only way to get the customer's data back. In the case of performance loss, a few minutes spent cleaning may prevent unnecessary replacement of service parts and present an opportunity to "fix the site" and help the customer prevent contamination in the future.

The following are recommendations for preventing contamination of disks and the disk drive:

- Place the library away from high traffic areas.
- Do not leave a disk in the drive for extended periods of time if possible.
- Do not use the library in "dirty" environments such as coal mines, railroad maintenance yards, etc.

### 4.3.1 Cleaning Tools Available

Disks may be cleaned with the Optical Disk Cleaning Kit (C1700-88800). This kit contains swabs and alcohol, cleaning instructions, and a special cartridge holder that keeps the sliding sleeve open. The Optical Disk Cleaning Kit is not a Digital stocked item. Refer to Appendix B for a list of supplies and ordering information.

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**Note**

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If the problem appeared as loss of performance and cleaning a disk solved the problem, another couple of steps must be done to regain performance using that disk.

As performance was declining because of read/write problems, the disk was probably becoming fragmented through excessive "sparing." To regain performance, the data on each side of the disk should be stored, each side of the disk reformatted, and the data restored back on the disk. Use either the online diagnostic DASDIAG or the offline diagnostic DOSDASS2 to rebuild the spares table. Refer to Appendix B for a list of parts and supplies, and ordering information.

---

---

**CAUTION**

---

Do not attempt to clean the optical drive objective lens! Although disk drive cleaning kits are available, they are not approved for use with the RW514/RW516/RW534/RW536. Using these kits to clean the drive in these libraries will damage the optical drive mechanism.

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## 4.4 Using the Eject Tool to Remove a Disk from the Drive

The optical drive mechanism does not automatically eject a disk from the drive if a power failure occurs. If you need to manually remove a disk from a drive with no power, you must use the eject tool.

If you do not have an eject tool for the optical drive, you may order one of these:

- Hewlett-Packard part number - C1701-88803
- Marshall Industries part number - R3322

Refer to Appendix B for a list of parts and supplies.



You may also use a small flat-head screwdriver with the following dimensions:

Length - 50 mm

Width - 2.45 mm

Thickness - .5 mm

A disk can be removed from the drive while the drive is still secured in the autochanger. Follow the service access procedures in Chapter 5 to access the front of the drive mechanism, and then follow these steps to remove a disk from the drive:

1. Disconnect all power to the drive if you have not done so already.
2. Insert the eject tool into the small round hole in the front panel of the drive.
3. Turn the eject tool in a clockwise direction (approximately 20 complete rotations) until the disk is ejected through the front of the drive.

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**CAUTION**

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Do not reach into the drive to get the disk. Wait until the disk is ejected through the front of the drive before removing it. Premature removal of the disk could damage the drive.

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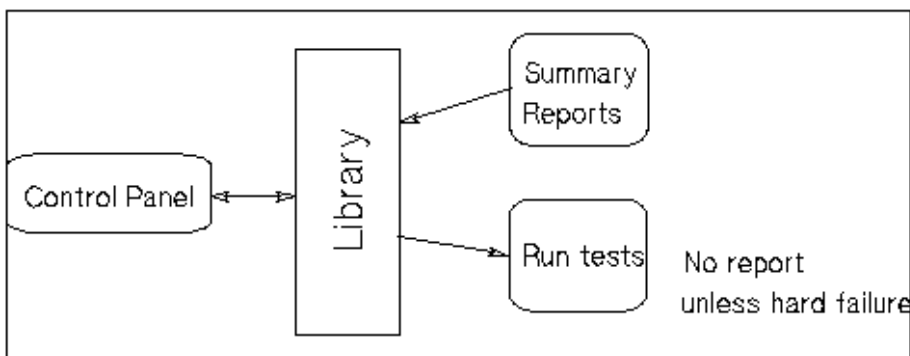
## 4.5 Troubleshooting Using the Control Panel and Observation

When there are errors in autochanger movements, two main approaches are available to obtain information and to run exciser tests. The approach usually depends on whether the error encountered was a hard error or whether it was a soft or intermittent error.

- Troubleshooting Using the Control Panel and Observation - This method is usually used in situations where you have a hard error.
- Troubleshooting Through the SCSI Bus - This method is used in situations where you have a soft or intermittent error.

Error information and logs accessed through the control panel are summarized. By knowing how the autochanger operates and using the summarized information from the control panel display, there is enough information to troubleshoot many problems that result in a hard error.

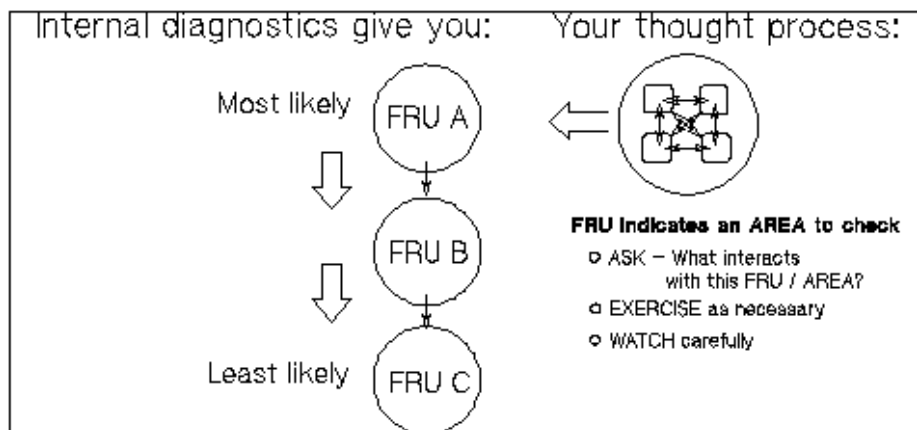
**Figure 4-1 Information and Tests Through the Control Panel**



### **4.5.1 The Autochanger Lists the First "Possibles"**

At power-on, and after every failed move, the autochanger automatically runs an initialization sequence that comprehensively tests the autochanger. If a hard failure occurs, a list of possible FRUs that may have been at fault is returned. Keep in mind that these FRUs are not listed in any prioritized manner. The Customer Engineer should visually verify the failure in progress to determine the most likely candidate.

Figure 4-2 The Autochanger Returns Suspect FRUs



**Note**

This test sequence returns possible failed FRUs only if there has been a **HARD FAILURE**. The test sequence will NOT find an intermittent failure. This test sequence, called the "FRU Isolation Test" (test 60), can also be run from the control panel. Similarly to its automatic operation, this test sequence only points out ("isolates") FRUs if there has been a hard failure.

**What the Autochanger Assumes**

The FRU isolation test assumes the following:

- There was a failure.
- The cause of the failure was physical (either mechanical or in the electronics).
- There is only one failed component. Simultaneous failures of unrelated items are not considered possible for purposes of this test.
- Service will be done, if necessary, if a problem is found (i.e., the unit does not have to be left in a "clean" state).

The test takes advantage of this and does whatever is necessary to determine the cause of the failure. Disks are not intentionally rearranged, but if the picker starts this test with a disk in it, the position and orientation of that disk is unknown.

When an error occurs, the cause may be the power supply, cables, drive electronics, motors, encoders, belts, gears, sensors, or picker. No assumption is made about the integrity of any of these components. To isolate the actual cause of the failure, a process of elimination is used.

The components are tested in a sequence that starts with the most basic functions and builds to the more complex, and interrelating components (i.e., the motors cannot be tested if the power supply is dead).

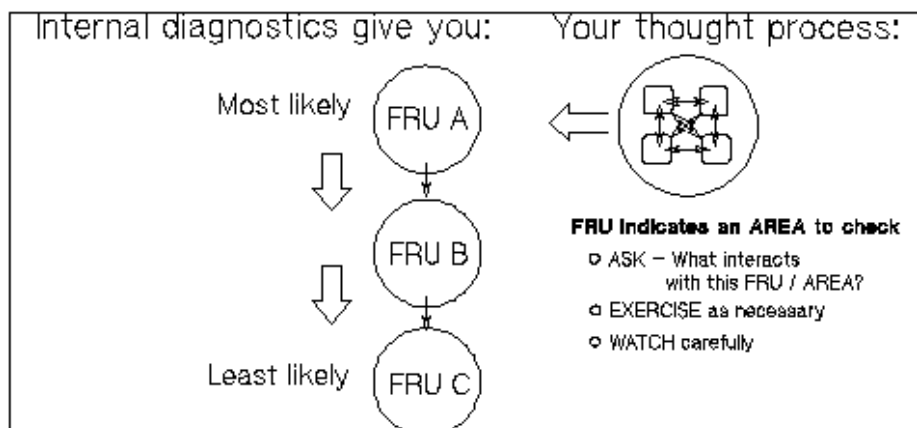
Whenever the initialization sequence is run, FIND HOME is attempted. If the "home" position cannot be found, the FRU isolation test is run automatically. When the FRU isolation test is run from the control panel, the FIND HOME sequence is run.

## 4.6 How to Use the Results of the Internal Tests

Similar to treating symptoms rather than the real problem, the suspect FRUs given by the FRU isolation test may actually mask the root cause of the problem.

The hard move error that caused the autochanger to run the FRU isolation test may have only been a PRODUCT of the actual problem. Blindly and repeatedly replacing the suspect FRU(s) will not solve the problem.

Figure 4-3 How Service Views the Suspect FRUs



If you consider the suspect FRU as a POINTER to the problem area rather than the problem itself, an educated visual inspection, with perhaps some cable and connector wiggling, should reveal the real problem.

A good visual inspection requires an understanding of how the autochanger acts under normal operation. This understanding can be achieved by completing the self-paced training for the autochanger and getting as much hands-on experience as possible. If you are familiar with the moves of the carriage/picker assembly during the FIND HOME sequence and you are familiar with the behavior of the drive, you will be able to more easily detect the real problem pointed to by a suspect FRU.

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**Note**

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The specific steps of the FIND HOME sequence and the possible errors which may result are listed in Section 4.12.

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An example:

The autochanger fails with an error code of 4D (hexadecimal), "MOTION ERROR CHECKING FOR CARTRIDGE IN THE PICKER," and lists the picker (FRU 27) as the most likely failure. However, when you observe the unit while running the Wellness Test (test 2), you see that the picker is having trouble flipping. As you manually move the carriage/picker assembly around and touch the components that are involved, you notice that the picker belt is abnormally tight. The belt is tight because the carriage motor is skewed.

The error (4D) and suspect FRU gave an AREA to look at when troubleshooting. Visual inspection (concurrent with physical checks) helps to link the suspect FRU with the root cause by providing an area to examine. In the preceding example, the components that INTERACT with, and DRIVE the picker are examined.

The section in this chapter entitled, "Recovery Procedures for Specific Hardware Errors," lists each error code and procedure for finding the cause of the error, using the autochanger's suspect FRUs as a guide. Error codes and recovery procedures are grouped by functional area in the autochanger.

At the BEGINNING of the list of errors for each functional group, you will find general HINTS about what areas should be checked when errors appear in that group. Be sure to check out those hints.

#### **4.6.1 The FRU Isolation Test Sequence**

The following list traces the execution of the FRU isolation test. A failure requires additional tests at that point to determine the actual cause. The original sequence is not continued if a test fails.

1. Look at the error code generated by the FIND HOME sequence, some codes may have obvious, implied FRUs. (eliminates optical sensors and their cables)

2. Run autochanger controller PCA tests that do not cause host communication (eliminates power supply, power supply cables, ROMs, RAM, motor control IC, and microprocessor)
3. Check that the motors are capable of moving by attempting to move them very small distances in both directions. (eliminates motor assemblies (except belts), motor cables, PCA drivers)
4. Pull picker fingers back. They should come to a hard stop. (eliminates all picker belts, picker belt tensioner)
5. Move carriage/picker assembly toward the drive. It should come to a hard stop. (eliminates the carriage belt)
6. Move carriage/picker assembly away from the drive. The move has to be far enough to be certain that the leadscrew can move, but not so far that a jammed cartridge will cause the test to fail. (eliminates the carriage leadscrew assembly)

If the FRU isolation test has been run from the front panel, the FIND HOME sequence will automatically be executed at this point.

7. At this point, there is some level of confidence that the system is capable of moving the carriage/picker assembly. Using the new information learned by running these tests, look at the error codes, the move ID that failed, and how the recovery system failed.

## 4.7 Information Logs

The optical disk library control panel diagnostic tests have two major purposes. The first is to provide diagnostic information that can lead to early detection of an autochanger problem. The second is to provide fault isolation tests.

All the logs are maintained within non-volatile RAM, and so are not affected by cycling autochanger power. These logs are accessible from the control panel by using the INFO option. For a list of information log selections, see Table 4-6.

### 4.7.1 Procedure

To display information about the autochanger (e.g., the error log or move success log), follow these steps.

1. With the Autochanger power on and in the READY state, press **OPTION**. TEST \* displays.
2. Press **NEXT** until INFO \* displays.
3. Press **ENTER**.

4. Press **NEXT** or **PREV** until the desired log number is displayed.
5. Press **ENTER**. The log information will be displayed.

---

**Note**

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Some logs will display more information when **NEXT** or **PREV** is pressed. Press **CANCEL** to stop the **INFO** display. Press **ENTER** to choose another log.

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## 4.8 Recovery from Hardware Errors

When a hardware failure occurs, a message is displayed on the control panel. If the failure occurs during the power-on sequence, **FAIL 1** is displayed. If the failure occurs at some other time, **MISLOAD** or **FAIL 0** is displayed. If a failure occurs while you are running a test, **FAIL #** is displayed, where # is the number of the test that failed.

When you press **ENTER**, the autochanger displays information about the hardware failure.

The autochanger firmware can detect broken components such as a dead motor, a missing belt, etc., but if failures are due to marginal or random problems, the failing component may induce errors in other components. For example, if any portion of the electronics becomes intermittent or if friction increases on a part, different components of the autochanger may appear to fail at varied points as the autochanger runs its code. This results in many different error codes.

Additional explanation of some hardware error codes follows the table of hardware error codes and recovery procedures.

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**Note**

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Instructions for running internal diagnostic tests are given in Section 4.10. A list of the available test choices and their descriptions are given in Section 4.11.

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### **4.8.1 Hardware Error Codes and Recovery Procedures**

Table 4-1 shows the hardware error codes possible and recovery procedures for specific hardware errors. In all cases, if you run a test, and no error occurs, monitor for reoccurrence. If the error repeats, use the list of suspect FRUs logged by the FRU isolation test as a guide to determine the problem. Replace the FRU(s) as necessary.

Some error codes require further explanation; see the section immediately following Table 4-1.



**Table 4–1 Hardware Error Codes and Recovery Procedures**

<b>Error Code (hex.)</b>	<b>Error</b>	<b>Recovery Procedures</b>
00	No error	No action.
<b>AUTOCHANGER CONTROLLER PCA ERRORS</b>		
		<b>The first step is to make sure autochanger pca cables are seated in their connectors.</b>
01	ROM Checksum Error	Run test 31—ROM Checksum Test – verify failure.
03	RAM Test Error	Run test 33—RAM Test—verify failure.
04	Microprocessor Test Error	Run test 30 – Microprocessor Operation Test—verify failure.
05	Controlled Area of RAM Checksum Error	Recycle Power—verify failure. <b>If error repeats –</b> Run configuration 16—resets default values. Recycle power. <b>If error repeats –</b> run Configuration 66 - Zeros all RAM locations and reboots. <b>CAUTION -</b> When this configuration is set to "Clear," the product ID and vendor ID are cleared and the code must be reloaded from the host. <b>If error repeats –</b> Replace autochanger controller PCA (FRU 01). Power-on—check fix.
06	Illegal interrupt seen by microprocessor	Same as for error code 05
07	Illegal CPU exception seen by microprocessor	Same as for error code 05
09	Firmware Error	Run test 3—Controller Test—(may not be able to duplicate).
<b>SCSI INTERFACE-SPECIFIC ERRORS</b>		
		<b>Visual inspection is not possible for errors 0B to 13.</b>
0B	SCSI Controller Register Error	Run test 34—SCSI Interface Controller Chip Test—verify failure.

(continued on next page)

**Table 4–1 (Cont.) Hardware Error Codes and Recovery Procedures**

<b>Error Code (hex.)</b>	<b>Error</b>	<b>Recovery Procedures</b>
0C	SCSI Controller IC's RAM Failed	Run test 34—SCSI Interface Controller Chip Test—verify failure.
0D	SCSI Controller Message Error	Run test 34—SCSI Interface Controller Chip Test—verify failure.
0E	SCSI Controller Command Error	Run test 34—SCSI Interface Controller Chip Test—verify failure.
0F	SCSI Controller Kill Error	Run test 34—SCSI Interface Controller Chip Test—verify failure.
10	SCSI Controller FIFO Error	Run test 34—SCSI Interface Controller Chip Test—verify failure.
11	SCSI Controller Target Sequence Error	Run test 34—SCSI Interface Controller Chip Test—verify failure.
12	SCSI Controller Command Sequence Error	Run test 34—SCSI Interface Controller Chip Test—verify failure.
13	SCSI Controller Status Sequence Error	Run test 34—SCSI Interface Controller Chip Test—verify failure.
<b>LOOPBACK ERRORS</b>		<b>CAUTION:</b> SCSI Loopback Test 41 will always fail when the SCSI repeater PCA is installed. All RW514/RW516/RW534 /RW536 libraries are shipped with the SCSI repeater PCA.
18	SCSI Connector Loopback Error in DBO or I/O	Run test 41—SCSI Connector Loopback Test (using loopback connector 88780-60095)—verify failure.
19	SCSI Connector Loopback Error in DB1 or C/D	Run test 41—SCSI Connector Loopback Test (using loopback connector 88780-60095)—verify failure.
1A	SCSI Connector Loopback Error in DB2 or MSG	Run test 41—SCSI Connector Loopback Test (using loopback connector 88780-60095)—verify failure.
1B	SCSI Connector Loopback Error in DB3 or REQ	Run test 41—SCSI Connector Loopback Test (using loopback connector 88780-60095)—verify failure.

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**Table 4–1 (Cont.) Hardware Error Codes and Recovery Procedures**

<b>Error Code (hex.)</b>	<b>Error</b>	<b>Recovery Procedures</b>
1C	SCSI Connector Loopback Error in DB4 or ACK	Run test 41—SCSI Connector Loopback Test (using loopback connector 88780-60095)—verify failure.
1D	SCSI Connector Loopback Error in DB5 or ATN	Run test 41—SCSI Connector Loopback Test (using loopback connector 88780-60095)—verify failure.
1E	SCSI Connector Loopback Error in DB6 or SEL	Run test 41—SCSI Connector Loopback Test (using loopback connector 88780-60095)—verify failure.
1F	SCSI Connector Loopback Error in DB7 or BSY	Run test 41—SCSI Connector Loopback Test (using loopback connector 88780-60095)—verify failure.
20	SCSI Connector Loopback Error in DBP or RST	Run test 41—SCSI Connector Loopback Test (using loopback connector 88780-60095)—verify failure.

**MOTOR CONTROL IC ERRORS**

**Visual inspection is not possible for errors 2C to 2E.**

2C	Failed read/write test to motor control IC	Run test 36 – Motor Control Chip Test—verify failure.
2D	Motor Control Loopback Test failed	Run test 36 – Motor Control Chip Test—verify failure.
2E	Motor Control IC RAM Test failed	Run test 36—Motor Control Chip Test—verify failure.

**POWER SUPPLY ERRORS**

**Visually check the power cables and connections.**

33	Low Voltage Power Supply failed	Run test 40—Power Supply Test—verify failure.  <b>If error repeats</b> - measure 12 V (see Figure 5–13, (2)) - measure at 4-prong Molex® that connects to J81 on mother PCA.
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**Table 4–1 (Cont.) Hardware Error Codes and Recovery Procedures**

Error Code (hex.)	Error	Recovery Procedures
34	High Voltage Power Supply failed	Run test 40—Power Supply Test—verify failure. <b>If error repeats</b> - measure 24 V (see Figure 5–13, (4)) - measure at 4-prong Molex® that connects to J81 on mother PCA.
<b>DRIVE CONNECT ERRORS</b>		
On error codes 38 and 39 be sure to check:		
<ul style="list-style-type: none"> <li>• drive cabling                             <ul style="list-style-type: none"> <li>– good contacts</li> <li>– no cut or exposed wires</li> </ul> </li> <li>• drive tray not skewed</li> </ul>		
38	Drive 1 not connected	Run test 37—Drive Connector Test—verify failure.
39	Drive 2 not connected	Run test 37—Drive Connector Test—verify failure.
3A	Drive 3 not connected	Run test 37—Drive Connector Test—verify failure.
3B	Drive 4 not connected	Run test 37—Drive Connector Test—verify failure.
<b>MECHANISM ERRORS</b>		
<b>Check carriage/picker for free motion. The carriage should travel easily along the rails; you should be able to smoothly translate the picker along the carriage. The picker should also flip easily by pulling the picker belt.</b>		
3C	Unspecified failure	Run test 11—Autochanger Mechanism Exercise Test. On error—go to error code in this table.
3E	Unspecified servo failure	Run test 11—Autochanger Mechanism Exercise Test—verify failure.

(continued on next page)

**Table 4–1 (Cont.) Hardware Error Codes and Recovery Procedures**

<b>Error Code (hex.)</b>	<b>Error</b>	<b>Recovery Procedures</b>
40	Unable to free picker fingers for carriage motion	<b>Check the picker, mailslot, and magazine for loose labels or other obstructions.</b> Run test 50—Find Home Sequence.
41	Unable to verify picker is at home position (non-leadcrew side)	Run test 50—Find Home Sequence—verify failure.
42	Unable to find home position; Path-Clear sensors blocked	Run test 50—Find Home Sequence—verify failure.
43	Unable to clear Path-Clear sensors by moving picker fingers back	Check drive and magazine for loose lables or other obstructions. Run test 50—Find Home Sequence.
44	Carriage motion failure during Find Home sequence	Run test 50—Find Home Sequence—verify failure.
45	Unable to free picker fingers for translate motion	Run test 50—Find Home Sequence—verify failure.
46	Carriage motion failed while initializing Home position (during Find Home)	Run test 50—Find Home Sequence – verify failure.
47	Translate failed while moving toward non-leadcrew side during Find Home sequence	Run test 50—Find Home Sequence – verify failure.
48	Carriage motion failed during carriage/picker assembly calibration (leadcrew side)	Run test 51—Carriage/Picker Assy Calibration—verify failure.
49	Carriage motion failed during carriage/picker assembly calibration (non-leadcrew side)	Run test 51 – Carriage/Picker Assy Calibration—verify failure.

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**Table 4–1 (Cont.) Hardware Error Codes and Recovery Procedures**

<b>Error Code (hex.)</b>	<b>Error</b>	<b>Recovery Procedures</b>
4A	Motion error while determining orientation of the picker	Run test 50—Find Home Sequence—verify failure.
4B	No sensor found	Run test 50—Find Home Sequence – verify failure.
4C	Failed flip motion during Find Home sequence	Run test 50—Find Home Sequence—verify failure.
4D	Motion error checking for cartridge in the picker	Run test 50—Find Home Sequence—verify failure.
4E	Unable to measure height of sensor on the leadscrew side	Run test 51—Carriage/Picker Assy Calibration—verify failure.
4F	Unable to measure height of sensor on non-leadscrew side	Run test 51—Carriage/Picker Assy Calibration—verify failure.
50	Excessive tilt of the carriage/picker assembly (away from the drives)	Run test 51—Carriage/Picker Assy Calibration – verify failure. <b>Check the optical sensors, if necessary.</b>
51	Excessive tilt of the carriage/picker assembly (toward drives)	Run test 51—Carriage/Picker Assy Calibration—verify failure. <b>Check the optical sensors, if necessary.</b>
52	Excessive cone angle on picker	Run test 51 – Carriage/Picker Assy Calibration—verify failure.
53	Excessive stack tilt	Run test 51 – Carriage/Picker Assy Calibration—verify failure. <b>Check the optical sensors, if necessary.</b>
54	Unable to complete an interrupted move (at power-up)	Run test 60—FRU Isolation Test—verify failure. If test 60 shows an error code, look up the hardware error code in this table and follow the recovery procedures for that error.
55	Unable to find top of unit	Run test 51 – Carriage/Picker Assy Calibration—verify failure.

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**Table 4–1 (Cont.) Hardware Error Codes and Recovery Procedures**

<b>Error Code (hex.)</b>	<b>Error</b>	<b>Recovery Procedures</b>
<b>EXERCISER TEST ERRORS</b>		
56	Need to issue Initialize Status command	No FRUs failed. Run test 10 to initialize the element status.
57	Invalid test configuration	No FRUs failed. Check cartridge configuration. Check that the cartridge configuration (number and location) are correct for the test you are doing.
59	Exerciser unrecovered error	No FRUs failed. Exerciser had an unrecovered error. Rerun exerciser. If exerciser fails again, access the recovery log. Recovery log is available only through the SCSI interface. Use the DOSDASS2 utility available through Hewlett-packard. Refer to Appendix B for order information.
5A	Invalid test configuration (elements reserved)	No FRUs failed. Can't do the selected test on a reserved cartridge. Check cartridge reservations. Rerun the test.
5B	Initialize Element Status command failed	No FRUs failed. The initialization of an element status failed. Rerun initialization. If initialization fails again, access the recovery log. Recovery log is available only through the SCSI interface. Use the DOSDASS2 utility available through Hewlett-packard. Refer to Appendix B for order information.
5C	Shipping diagnostic run with cartridges in autochanger mechanism	No FRUs failed. Shipping warning. Take all disks out of the optical drives.
<b>CALIBRATION SENSOR SYSTEM ERRORS</b>		
60	Optical sensor failed (leadscrew side)	Run test 51 – Carriage/Picker Assy Calibration—verify failure.
61	Optical sensor failed (non-leadscrew side)	Run test 51 – Carriage/Picker Assy Calibration—verify failure.
62	Optical sensor failed (leadscrew side near mailslot)	Run test 51—Carriage/Picker Assy Calibration—verify failure.

(continued on next page)

**Table 4–1 (Cont.) Hardware Error Codes and Recovery Procedures**

<b>Error Code (hex.)</b>	<b>Error</b>	<b>Recovery Procedures</b>
63	Optical sensor failed (non-lead screw side near mailslot)	Run test 51—Carriage/Picker Assy Calibration—verify failure.
<b>PATH-CLEAR SENSOR SYSTEM ERRORS</b>		
64	Intermittent path-clear sensor beam (lead screw side)	Run test 51—Carriage/Picker Assy Calibration—verify failure.
65	Intermittent path-clear sensor beam (non-lead screw side)	Run test 51—Carriage/Picker Assy Calibration—verify failure.
66	Path physically blocked (lead screw side)	Run test 51—Carriage/Picker Assy Calibration—verify failure.
67	Path physically blocked (non-lead screw side)	Run test 51—Carriage/Picker Assy Calibration—verify failure.
6B	Path-clear LED failed (lead screw side)	Run test 51—Carriage/Picker Assy Calibration—verify failure.
6C	Path-clear LED failed (non-lead screw side)	Run test 51—Carriage/Picker Assy Calibration—verify failure.
6D	Path-clear sensor failed (lead screw side)	Run test 51—Carriage/Picker Assy Calibration—verify failure.
6E	Path-clear sensor failed (non-lead screw side)	Run test 51—Carriage/Picker Assy Calibration—verify failure.
6F	Path-clear sensor system failed	Run test 51—Carriage/Picker Assy Calibration—verify failure.
<b>MAILSLOT/STORAGE SLOT ERRORS</b>		
<b>Check for loose labels or other obstructions in errors that involve the mailslot (B0-B2).</b>		
B0	Mailslot will not rotate	Run test 17—Mailslot I/O Test—verify failure.
B1	Inside mailslot sensor failed	Run test 17—Mailslot I/O Test—verify failure.
B2	Mailslot will not accept or release cartridge	Run test 17—Mailslot I/O Test—verify failure.

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**Table 4–1 (Cont.) Hardware Error Codes and Recovery Procedures**

Error Code (hex.)	Error	Recovery Procedures
		<b>Check for loose labels or other obstructions in errors B3 and B4. Also, make sure that the magazines are not skewed.</b>
B3	Storage slot will not accept or release cartridge	Run test 15—Storage Slot Test—verify failure.
B4	Outside mailslot sensor failed	Run test 17 – Mailslot I/O Test—verify failure.

**DRIVE ERRORS**

**The autochanger only checks for the PRESENCE of a drive. To run complete drive tests requires an external diagnostic.**

**On drive error codes, check all cabling to/from the drive**

- **no broken wires**
- **no worn cables**
- **no loose connections**

**Check the drive tray.**

B8	Drive 1 access error	Run test 16—Drive I/O Test – verify failure.
B9	Drive 2 access error	Run test 16—Drive I/O Test – verify failure.
BA	Drive 3 access error	Run test 16—Drive I/O Test – verify failure.
BB	Drive 4 access error	Run test 16—Drive I/O Test – verify failure.

**DRIVE EJECT ERRORS**

BC	Drive 1 access failure	Run test 16—Drive I/O Test – verify failure.
BD	Drive 2 access failure	Run test 16—Drive I/O Test – verify failure.
BE	Drive 3 access failure	Run test 16—Drive I/O Test – verify failure.
BF	Drive 4 access failure	Run test 16—Drive I/O Test – verify failure.

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**Table 4–1 (Cont.) Hardware Error Codes and Recovery Procedures**  
**FRU DETECTION TEST ERRORS**

		<p><b>Check carriage/picker for free motion. The carriage should travel easily along the rails; you should be able to smoothly translate the picker across the carriage.</b></p> <p><b>You should be able to easily flip the picker using the picker belt.</b></p>
C8	Unable to gain proper servo control of motors	Run test 60—FRU Isolation Test—verify failure. Replace the FRUs if necessary.
C9	Unable to move picker motor	Run test 60—FRU Isolation Test—verify failure. Replace the FRUs if necessary.
CA	Unable to move carriage motor	Run test 60—FRU Isolation Test—verify failure. Replace the FRUs if necessary.
CB	Unable to move either motor	Run test 60—FRU Isolation Test—verify failure. Replace the FRUs if necessary.
CC	Unable to find a hard stop while turning the picker motor	Run test 60—FRU Isolation Test—verify failure. Replace the FRUs if necessary.
CD	Unable to find a hard stop while turning the carriage motor	Run test 60—FRU Isolation Test—verify failure. Replace the FRUs if necessary.
CE	Excessive force needed to move the carriage leadscrew	Run test 60—FRU Isolation Test—verify failure. Replace the FRUs if necessary.

**MISCELLANEOUS ERROR Codes**

FA	Invalid switch configuration	
FB	Door interlock open	
FC	The test can not be run from the SCSI interface	
FD	The test can only be run from the SCSI interface	
FE	The test did not run	Probably a configuration error
FF	Invalid test number	

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## 4.8.2 Additional Explanation of Some Hardware Error Codes

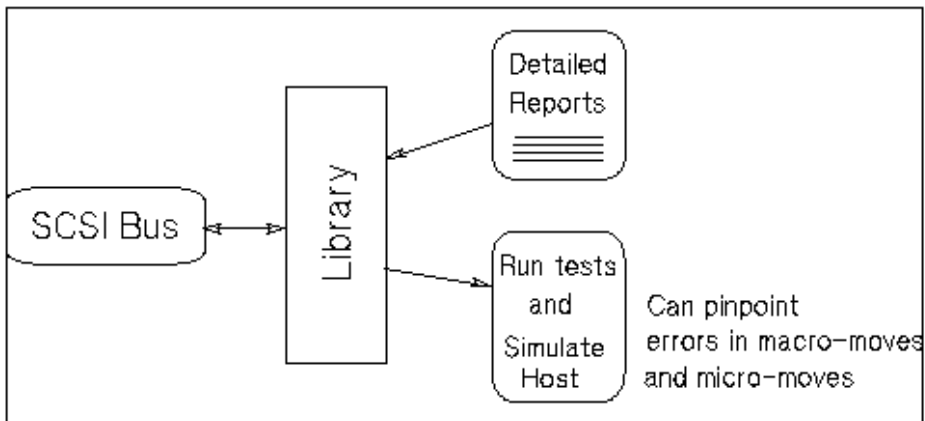
Error Code	Explanation
05	<p>Controlled area of RAM checksum error.</p> <p>All of the RAM on the autochanger controller board has battery back-up, but not all of it needs to be retained upon power loss. The portion of the RAM which needs to be valid at poweron is referred to as "controlled RAM." The stored checksum is re-calculated on this area every time the "controlled RAM" is modified. The checksum is verified by Test #32. Error 05H is returned any time the calculated checksum does not match the stored checksum. To reset the checksum, clear Configuration 16 using the control panel and switch the autochanger off and on again.</p> <p>This error is deemed to be so unacceptable that all autochanger function is halted. The motors are turned off and the SCSI bus is not accessed.</p>
09	<p>Firmware error</p> <p>There are three conditions where this code is used, case statement which falls through, stack overflow, divide by zero</p> <p>In case 1, the error code is returned over SCSI to the host. In cases 2 and 3, the motors shut down, the processor halts.</p>
43-4C	<p>See "The FIND HOME sequence" in Section 4.12 for a thorough explanation of the Find Home test.</p>
50	<p>Excess upward droop on picker.</p>
51	<p>Excess downward droop on picker.</p> <p>"Droop" is the distance between where the end of a perfectly perpendicular picker (in relationship to the carriage) would be, and where the end of this picker is MEASURED to be. If the picker droops down too far, it will not be able to engage the mailslot correctly. It will first engage the translate pin and move across, rather than out.</p>
52	<p>Excessive cone angle on picker.</p> <p>If the sum of the upward droop on one side of the picker plus the downward droop on the other side of the picker is too great for proper operation, this error is returned.</p>
53	<p>Excessive stack tilt.</p> <p>The height of each side of the autochanger, or "stack", is the height of each of the two sensors. Tilt is the measure of the difference of the heights of the sides. If the tilt is too great for proper operation, this error is returned.</p>

Error Code	Explanation
54	<p>At power up, unable to complete an interrupted move.</p> <p>If a move was interrupted by a power failure, at the next poweron the autochanger will attempt to return the library to the state it was in before that command was issued. This error is returned if all the poweron tests pass, but the autochanger is unable to put the cartridge(s) back.</p>
B8-BF	<p>Drive Errors.</p> <p>Errors B8 through BB appear when a drive cannot come to a READY state.</p> <p>Errors BC through BF appear if there is a problem either inserting or ejecting a cartridge. These errors also occur when either the drive eject mechanism has failed or the drive eject-control solenoid will not allow the cartridge to come out and be grabbed by the picker.</p>
C8	<p>Unable to close the loops on the motors.</p> <p>When this error occurs, the FRU Isolation code has already confirmed that the motors and encoders appear functional. But, for some reason, the servo system is unable to initiate proper control. This condition is rare.</p>
CC	<p>Unable to find a hard stop while turning the picker motor.</p>
CD	<p>Unable to find a hard stop while turning the carriage leadscrew motor.</p> <p>The FRU Isolation code checks for the presence of the belts by turning the motors until the mechanical system hits something. These errors are returned if the motors continue to spin longer than the maximum expected distances.</p>

## 4.9 Error Information Through SCSI Commands

Troubleshooting through the SCSI bus is used in situations where you encounter a soft or intermittent error. Using data on the SCSI bus, you can determine exactly what the autochanger was doing when a failure occurred; all the way down to the macro-move and micro-moves. Also, through the Log Sense and Request Sense commands, you can gather information on the optical drives; which cannot be done through the control panel.

Figure 4-4 Information and Tests Through the SCSI Bus



Refer to the following information when troubleshooting through the SCSI bus:

- Request Sense Command Tables - located in Appendix A.  
These tables show error information and information about the state of the autochanger after an error has occurred, which is returned when a Request Sense command is issued through the SCSI bus.
- Log Sense Command Tables - located in Appendix A.  
These tables show the error and move information which is stored in various logs during autochanger operation and when running internal diagnostics.

## 4.10 Diagnostics

Several diagnostic programs and tests are available for the optical disk library. This section provides information on how to run these tests/programs or where to find this information.

The main types of diagnostics available for the disk library are internal diagnostics. These tests are run from the control panel and are divided into four groups: sequence tests, exerciser tests, electronic core tests, and mechanism core tests. These tests are fully explained in Section 4.11.

### 4.10.1 Offline Diagnostics

A diagnostic utility called DOSDASS2 is available from Hewlett-Packard for accessing the optical disk library through the SCSI bus.

DOSDASS2 fully exercises either standalone multifunction optical drives or optical disk libraries that contain multifunction optical drives. Information for obtaining DOSDASS2 is found in Appendix B of this manual.

### 4.10.2 Internal Diagnostic Tests

An extensive set of diagnostic tests are available for the optical disk library. Except for the poweron sequence test, the running of tests is not automatic. The operator may initiate each test from the control panel.

A test is actually a sequence of separate tests that are called and run in series. Each test exercises a specific portion of the autochanger. Each test is identified by a test number that is requested when the test is to be run. Tests return either PASS or FAIL.

All the tests are combined into groups of similar functions.

*Sequence Tests* (1 - 9) execute sequences of individual tests within the range of Test 10 through Test 69. Sequences may be used to either test many portions of the autochanger or as an autochanger exerciser. When a sequence test is selected, the autochanger executes the tests in sequence until an error occurs or until the sequence successfully completes.

*Exerciser Tests* (10 - 29) do simple autochanger mechanism moves to check out elementary functions.

*Electronics Core Tests* (30 - 49) run basic tests of the controller PCA.

*Autochanger Mechanism Core Tests* (50 - 70) run basic tests of the autochanger mechanism. These tests make combinations of moves that can help to detect the source of failures.

Section 4.11 contains a complete listing and description of these diagnostic tests. Instructions for running these tests are provided in the following paragraphs.

### Procedure for Running Tests

To display test information and to choose tests to execute, access the TEST option by following these steps:

1. With the optical disk library power on and in the READY state, press **[OPTION]**. TEST \* displays.
2. Press **[ENTER]**. TEST 0 displays.
3. Press **[NEXT]** or **[PREV]** until the test number you want shows in the display.
4. Press **[ENTER]** to choose the test. ONCE displays. You may accept ONCE by pressing **[ENTER]** or press **[NEXT]** or **[PREV]** to choose 10, 100, 1000, or LOOP times. LOOP runs the test continuously until **[CANCEL]** is pressed or the unit is powered off.

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#### Note

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Any test may be stopped, at any time, by pressing **[CANCEL]**. The unit will stop the test after it completes its current activity.

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5. Once you have pressed **[ENTER]** for the number of times the test will repeat, RUN nn displays.
6. At this point the test runs. If no problems are encountered, the message PASS nn displays. You may press **[OPTION]** to get back to the READY state; or, you may press **[ENTER]** or **[CANCEL]** to run another test.
7. If a problem occurs during the test, the message FAIL nn displays. Press **[ENTER]** to gain information about the failure. An ERROR nn displays. The error log stores the FRU information, TEST nn information, and a time stamp.

## 4.11 Diagnostic Test Command Descriptions

The following is a description of the diagnostic test commands. Sequences may combine both exercisers and tests.

### 4.11.1 Sequence Tests

Table 4–2 Sequence Tests

No.	Test Name	Description
1	Poweron	<p>Checks all digital data paths and normal machine operation. This test runs the same sequence of TESTS as when initiated by an actual power on, but does NOT do all operations (see below).</p> <p>Sequence Order:</p> <ul style="list-style-type: none"><li>3 - Controller Test</li><li>40 - Power Supply Test</li><li>– Motor Connection Test (no number)</li><li>5 - Initialize Mechanism</li><li>46 - Board Configuration</li><li>– Restore (if needed). If power failed in the middle of a move, the autochanger tries a "restore" of the last move. The autochanger tries to put the cartridge back to where it came from. This attempt could fail (Poweron sequence would fail). POWERON ONLY.</li><li>10 - Initialize Element Status (if needed).</li><li>38 - "Light Show" in the indicators of the control panel.</li><li>– Mailslot rotation (if not secured). This rotation could fail(Poweron sequence would fail). POWERON ONLY.</li></ul>
2	Wellness Test	<p>Checks out the general capability of the autochanger. Needs one loaded cartridge; drives and mailslot empty.</p>

(continued on next page)



**Table 4–2 (Cont.) Sequence Tests**

No.	Test Name	Description
3	Controller Test	<p>This sequence is run by the autochanger controller at poweron to check out all paths, and operation of the servo motor and autochanger circuitry.</p> <p>Sequence Order:</p> <ul style="list-style-type: none"><li>30 - Processor Test</li><li>31 - ROM Checksum Test</li><li>33 - Non-Destructive RAM Test</li><li>32 - RAM Checksum Test</li><li>34 - SCSI Interface Controller IC Test</li><li>36 - Motor Control IC Test</li><li>35 - Multi-Function Peripheral IC Test</li><li>31 - ROM Checksum Test</li><li>33 - Non-Destructive RAM Test</li><li>32 - RAM Checksum Test</li><li>34 - SCSI Interface Controller IC Test</li><li>36 - Motor Control IC Test</li><li>35 - Multi-Function Peripheral IC Test</li><li>31 - ROM Checksum Test</li><li>33 - Non-Destructive RAM Test</li><li>32 - RAM Checksum Test</li><li>34 - SCSI Interface Controller IC Test</li><li>36 - Motor Control IC Test</li><li>35 - Multi-Function Peripheral IC Test</li><li>37 - Drive Connect Test</li></ul>
5	Initialize Mechanism	<p>Prepares the unit for movement.</p> <p>Sequence Order:</p> <ul style="list-style-type: none"><li>Initialize RAM variables to defaults</li><li>50 - Find Home</li></ul>

**Table 4–3 Exerciser Tests**

No.	Test Name	Description
10	Initialize Element Status	Does the same function as the SCSI Initialize Element Status command. It physically scans the entire unit to determine which storage slots and drives have disks.
11	Mechanism Exercise Test	Makes a combination of moves with a PASS/FAIL result. This exerciser is a sequence of other exerciser tests—12, 13, 14, 15, 16, and 17. This exerciser returns an error code #57H Invalid Configuration if there are no cartridges loaded into the unit, or if any drive is full. Needs one loaded cartridge.
12	Carriage/Picker Move Test	Moves the carriage/picker assembly the full length of the rails with the picker on first one side, then the other. Returns PASS/FAIL. No cartridges are required.
13	Translate Test	Makes a combination of moves with a PASS/FAIL result. It does several translations from various starting positions. No cartridges are required.
14	Flip Test	Makes a combination of moves with a PASS/FAIL result. It does several flips at various locations. No cartridges are required.
15	Storage Slot Test	Makes a combination of moves with a PASS/FAIL result. It moves a cartridge from a randomly-chosen full to a randomly-chosen empty slot, with a random flip. It then moves the cartridge back to its original storage slot with its original orientation. This exerciser returns an error code 57H, Invalid Configuration, if there are no cartridges loaded into the unit or if all storage slots are full. Needs one loaded cartridge.
16	Drive I/O Test	Makes a combination of moves with a PASS/FAIL result. It moves a cartridge from a randomly-chosen full slot to a drive, with a random flip. It then moves the cartridge back to its original slot with its original orientation. It does this once for each optical drive. Returns an error code 57H, Invalid Configuration, if there are no cartridges loaded into the unit or if any drive is loaded. Needs one loaded cartridge; drives must be empty.

(continued on next page)

**Table 4–3 (Cont.) Exerciser Tests**

No.	Test Name	Description
17	Mailslot I/O	Makes a combination of moves with a PASS/FAIL result. It moves a cartridge from the lowest-numbered full slot to the mailslot with a random flip. It then moves the cartridge back to its original slot with its original orientation. Returns error code 57H, Invalid Configuration if there are no cartridges loaded into the unit or if the mailslot is full. Needs one loaded cartridge; mailslot must be empty.
18	Speed Factor Setting Utility	Allows the setting of the speed factor as the first parameter given. The speed factor determines how fast the system moves the mechanics. The number provides 1/Parameter speed (e.g., Parameter=3 runs the motors at 1/3 of full speed). <b>This test can only be run from the SCSI Interface.</b>
19	Zero Maximum Force Log	The maximum force log is initialized to all zeros.
20	Set Speed Factor to Full Speed	Allows the mechanics to be run at full speed.
21	Set Speed Factor to Half Speed	Allows the mechanics to be run at half speed.
22	Set Speed Factor to Quarter Speed	Allows the mechanics to be run at quarter speed.
23	Shipping	Moves the picker to the appropriate position for preparation for shipping.
24	Fill Picker	Moves a cartridge into the picker from the first storage slot.
25	Empty Picker	Moves a cartridge from the picker to the first empty storage slot.
26	Zero Runtime Log	The entire runtime log is initialized to all zeros.
27	Set Minimum Retries	This sets the number of retries to 1. This may be set to see if the chosen test is doing what you want it to do. After you are satisfied that the test is what you want, run test 28 which resets the number of retries to default values.
28	Set to Default Number of Retries	Resets the number of retries to powerup default values. Used after setting retries to 1 by test 27.
29	Zero Error Log	Zeroes the Error Log.

## 4.11.2 Electronic Core Tests

**Table 4–4 Electronic Core Tests**

No.	Test Name	Description
30	Microprocessor Operation Test	Does a functional check of the microprocessor. This test must shut down the servo system; a Initialize Mechanism Test is run when this test finishes.
31	ROM Checksum Test	Does a checksum verification of the ROM.
32	RAM Checksum Test	A checksum of the "Controlled" area of RAM is kept on a continuous basis. This test verifies that the checksum is still valid.
33	Non-Destructive RAM Test	Tests all the controller's RAM, checking for data acceptance and retention. The test is non-destructive to RAM unless interrupted by power failure. To run correctly, this test must shut down the servo system; as a result, a Initialize Mechanism Test runs when this test finishes.
34	SCSI Interface Controller Chip Test	Checks out operations of the SCSI interface controller chip. This test will not be run if initiated via SCSI, it reports PASS.
35	Multi-Function Peripheral Chip Test	Tests the functionality of the Multi-Function Peripheral chip. It verifies the timer by comparing it to the CPU clock and tests RS-232 capabilities with an on-chip loopback.
36	Motor Control Chip Test	Exercises the registers of the motor control IC. To run correctly, this test shuts down the servo system.
37	Drive Connect Test	Checks for expected drive configuration. This is done by polling the drive connect signal on each of the possible drives. This line is grounded at the drive end if a drive is connected. If the drives physically connected do not match the expected configuration, then an error is reported.
38	Control Panel Light Show	Lights each portion of the display individually and then together. No feedback; always passes.
39	Control Panel Button Check	Displays the name of the button pressed. Press <input type="button" value="CANCEL"/> twice to exit.
40	Power Supply Test	Looks at both the 12-Volt and the 24-Volt pow that they are within limits. The limits for the 12V supply are 11V and 13V and the 24V supply limits are 23.5V and 25.5V.

(continued on next page)

**Table 4–4 (Cont.) Electronic Core Tests**

No.	Test Name	Description
41	SCSI Connector Loopback Test (interactive)	Runs a loopback through SCSI connectors, checking proper operation of the SCSI drivers, receivers, and cables. Requires an external loopback hood with terminator power. Will not run if initiated via SCSI; if so, it reports error FCH Test Did Not Run.
42	Optical Sensor Test (and Mailslot) (interactive)	Checks the status of the two optical sensors. Also checks the Mailslot sensor (see test 43). Three "0"s are placed on the control panel display; one at the left position in the display, one in the middle of the display, and one at the right position in the display. The mark is an open zero if the sensor is not blocked, and a zero filled in with lit segments if a sensor is blocked. No FRU is returned.
43	Mailslot Sensor Test (and Optical Sensor) (interactive)	See description for test 42.
50	Find Home Sequence	Moves the picker to a known "home" spot. This test assumes nothing about the state of the mechanics. The "home" location is at the lower left position of the box. The servo system is initialized to the "home" location. It then automatically runs test 51.
51	Carriage /Picker Assembly Calibration Test	Runs the portion of the mechanism recalibration related to the optical sensors. It measures sensor offsets and calculates picker tilt and droop. This test assumes that the mechanics and servo system are functional.
60	FRU Isolation Test	Assumes that something has physically failed, either electronic or mechanical. A series of special low level tests are run to select the three (or fewer) FRUs that are most likely to be at fault. Tests 30, 31, 33, 35, 36, 40, and 50 are executed as a part of the isolation process. Returns an error code, three suspect FRUs in decreasing order of fault probability, and a time stamp.

(continued on next page)

**Table 4–4 (Cont.) Electronic Core Tests**

No.	Test Name	Description
65	Calibrate Magazines	<p>Calculates a min/max clearance for a magazine. (The selected magazine should be empty.) The autochanger requires a disk in the mailslot. The test passes if clearance is 85 encoder counts (1 mm) up and down. (See info 23 for actual values.)</p> <p>If this test is run by SCSI command, set Byte 1 to the magazine number. (Model 60C contains 11 magazines; Model 100C contains 18 magazines.) The test returns: PASS or FAIL.</p>
66	Clear Magazine Offset	Clears the value calculated in test 65.
67	Calibrate Mailslot	Calculates an offset for the Mailslot. The Autochanger requires a disk in the Mailslot.
68	Clear Mailslot Offset	Clears the value calculated in test 67.
70 - 74	Reserved	For design/production use only.
75	UPS Test	<p>Tests whether or not the UPS is connected properly.</p> <p>The test returns <b>PASS</b> if connected properly, <b>FAIL</b> if the UPS is not connected properly or if there is no UPS connected.</p>
76 - 80	Reserved	For design/production use only.

## 4.12 The FIND HOME Sequence

The following FIND HOME sequence executes all the motions used in normal autochanger operation. Understanding the motions explained here, and the likely errors during these motions, should help you diagnose problems that may be occurring in the unit you are working on.

Each large movement in the FIND HOME sequence is called out, along with the micro-moves that formed this movement (given by Micro-move ID Numbers, MMID# *n..n*). If there is a problem during a movement, the most likely hardware error is listed.

Figure 4–5 shows the sequence graphically. The numbers of the following steps correspond to the numbers on the diagram.

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### Note

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When running the FIND HOME sequence, you will be able to see what the mechanism was attempting when an error occurred by setting RETRIES to 1 (Test 27). When limited to a single execution, the autochanger is prevented from entering any error recovery sequences.

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### Note

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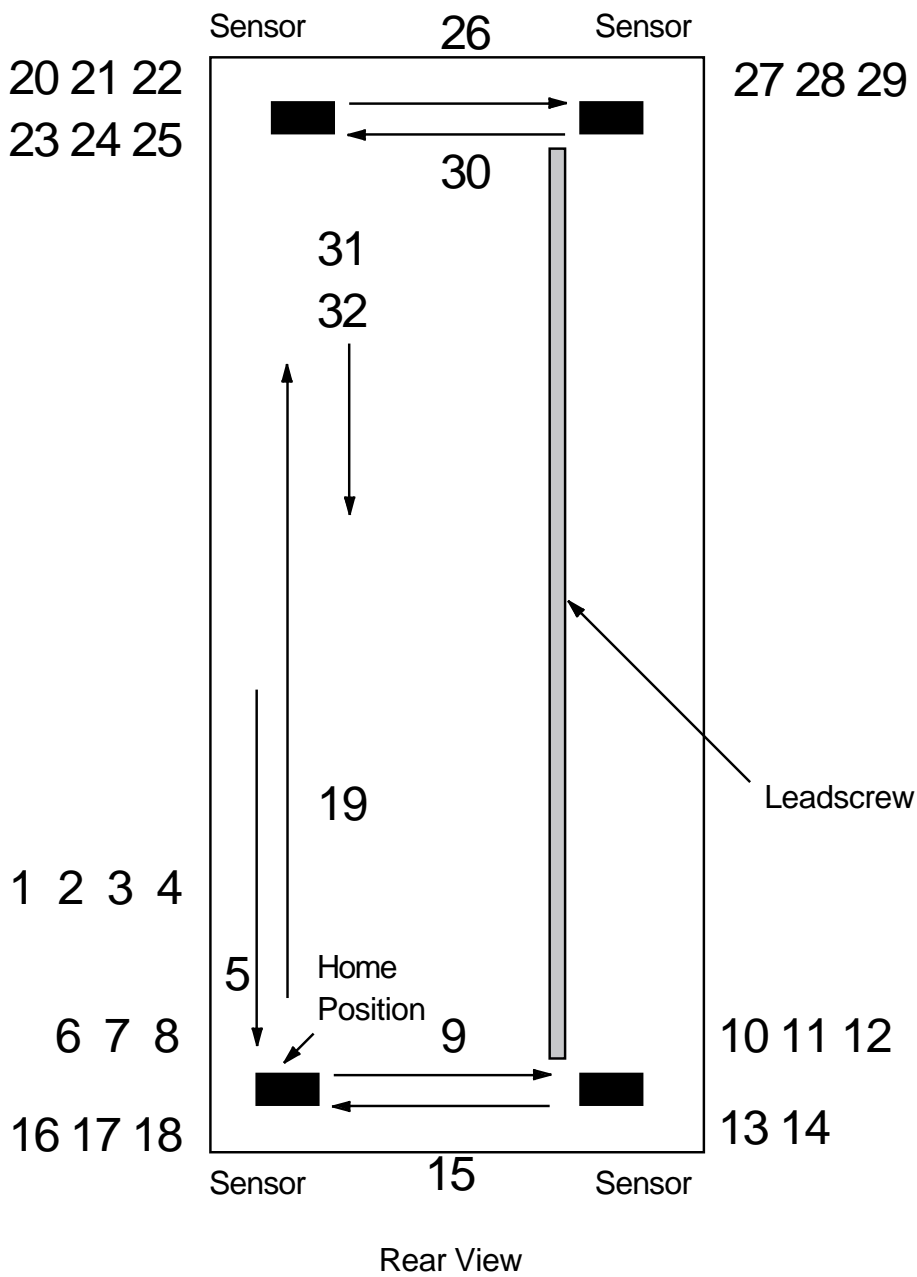
If you want to examine movements more closely, set the speed to half or quarter speed (Test 21 or Test 22).

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Error numbers are in hexadecimal notation.

1. Lock loops. (MMID# 82)
  - a. Possible error:
    - C8–Unable to gain proper servo control of the motors
2. Clear the picker of any obstructions that would prevent carriage/picker movement. (MMID# 62 to 67)
  - a. Possible error:
    - 40–Unable to free the picker fingers in preparation for carriage motion.

Figure 4-5 The "FIND HOME" Sequence





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**Note**

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These steps are repeated, in order, until all pass or until any four failures accumulate. If four failures occur, the errors are diagnosed to three FRUs and a hardware error code is reported.

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3. Clear an area large enough to enable a flip to take place. (MMID# 4B to 4F)
  - a. Possible error #1:  
44–Carriage motion failure during the Find Home sequence.
  - b. Possible error #2:  
66–Path physically blocked (leadscrew side)
  - c. Possible error #3:  
67–Path physically blocked (non-leadscrew side)
4. Initialize the picker fingers by pulling the fingers back to a hard stop. (MMID# 4F, 50, 60, 2)
  - a. Possible error:  
45–Unable to free the picker fingers in preparation for translate motion.
5. Initialize the carriage/picker position by moving it toward the drive-end of the unit until it hits a hard stop. (MMID# 2, 49, 4A)
  - a. Possible error:  
46–Carriage motion failed while initializing Home position during Find Home sequence.
6. Find the non-leadscrew side of unit. (MMID# 47, 48)
  - a. Possible error:  
47–Translate failed while moving toward the non-leadscrew side during the Find Home sequence.
7. Verify the non-leadscrew side of the unit. (MMID# 5D, 1)
  - a. Possible error #1:  
61–Optical sensor failed (non-leadscrew side - near drives)
  - b. Possible error #2:  
66–Path physically blocked (leadscrew side)
  - c. Possible error #3:

- 67–Path physically blocked (non-leadscrew side)
- d. Possible error #4:
  - 41–Unable to verify that the picker is at the home position during Find Home sequence (non-leadscrew side)
- 8. Initialize the picker fingers by pulling the fingers back to a hard stop. (MMID# 4F, 50, 60, 2)
  - a. Possible error:
    - 45–Unable to free the picker fingers in preparation for translate motion.
- 9. Translate to the leadscrew side. (MMID# 2, 4, E, 10)
  - a. Possible error:
    - 4A–Motion error while determining the orientation of the picker.
- 10. Find the picker side. (MMID# 1, 56, 2)
  - a. Possible error #1:
    - 4A–Motion error while determining the orientation of the picker.
  - b. Possible error #2:
    - 60–Optical Sensor failed (leadscrew side - near drives).
- 11. Calibrate the downward-facing picker tab against lower leadscrew-side sensor. (MMID# 5D, 5E, 1)
  - a. Possible error #1:
    - 48–Carriage motion failed during carriage/picker assembly calibration (leadscrew side).
  - b. Possible error #2:
    - 60–Optical sensor failed (leadscrew side - near drives)
- 12. Flip the picker. (MMID# 2, 8, C, 3, A, 9)
  - a. Possible error:
    - 4C–Failed flip motion during Find Home sequence.
- 13. Calibrate the downward-facing picker tab against the lower leadscrew - side sensor.
  - a. Possible error:
    - 48–Carriage motion failed during carriage/picker assembly calibration (leadscrew side).

14. Verify the picker side. ( MMID# 1, 2, 56)
  - a. Possible error #1:  
60–Optical sensor failed (leadscrew side - near drives)
  - b. Possible error #2:  
4A–Motion error while determining the orientation of the picker
15. Translate to the non-leadscrew side. (MMID# 1, 4, E, 11)
  - a. Possible error:  
49–Carriage motion failed during carriage/picker assembly calibration (non-leadscrew side)
16. Calibrate the downward-facing picker tab against lower non-leadscrew - side sensor. (MMID# 5D, 5E, 1)
  - a. Possible error #1:  
61–Optical sensor failed (non-leadscrew side - near drives)
  - b. Possible error #2:  
49–Carriage motion failed during carriage/picker assembly calibration (non-leadscrew side)
17. Flip the picker. (MMID# 2, 8, C, 3, A, 9)
  - a. Possible error:  
4C–Failed flip motion during Find Home sequence.
18. Calibrate the downward-facing picker tab against lower non-leadscrew - side sensor. (MMID# 5D, 5E, 1)
  - a. Possible error #1:  
61–Optical sensor failed (non-leadscrew side - near drives)
  - b. Possible error #2:  
49–Carriage motion failed during carriage/picker assembly calibration (non-leadscrew side)
19. Go to the top of the unit. (MMID# 1)
  - a. Possible error:  
4A–Motion error while determining the orientation of the picker
20. Verify the picker side. (MMID# 2, 56, 5C, 15, 13)
  - a. Possible error #1:  
4A–Motion error while determining the orientation of the picker

- b. Possible error #2:
  - 63–Optical sensor failed (non-lead screw side - near mailslot)
- 21. Find the top hard stop. (MMID# 5C, 15, 13)
  - a. Possible error:
    - 55–Unable to find top of unit
- 22. Calibrate the upward-facing picker tab against upper non-lead screw - side sensor. (MMID# 5D, 5E, 3)
  - a. Possible error #1:
    - 63–Optical sensor failed (non-lead screw side - near mailslot)
  - b. Possible error #2:
    - 49–Carriage motion failed during carriage/picker assembly calibration (non-lead screw side)
- 23. Flip the picker. (MMID# 2, 8, C, 3, A, 9, 1)
  - a. Possible error:
    - 4C–Failed flip motion during Find Home sequence.
- 24. Calibrate the upward-facing picker tab against upper non-lead screw - side sensor. (MMID# 5D, 5E, 3)
  - a. Possible error #1:
    - 63–Optical sensor failed (non-lead screw side - near mailslot)
  - b. Possible error #2:
    - 49–Carriage motion failed during carriage/picker assembly calibration (non-lead screw side)
- 25. Verify the picker side. (MMID# 56, 2, 3)
  - a. Possible error #1:
    - 4A–Motion error while determining the orientation of the picker
  - b. Possible error #2:
    - 63–Optical sensor failed (non-lead screw side - near mailslot)
- 26. Translate to the lead screw side. (MMID# 2, 5, 12, 14)
  - a. Possible error:
    - 48–Carriage motion failed during carriage/picker assembly calibration (lead screw side).

27. Calibrate the upward-facing picker tab against upper leadscrew-side sensor. (MMID# 5D, 5E, 3)
  - a. Possible error #1:  
62–Optical sensor failed (leadscrew side - near mailslot)
  - b. Possible error #2:  
48–Carriage motion failed during carriage/picker assembly calibration (leadscrew side).
28. Flip the picker. (MMID# 2, 8, C, 3, A, 9, 1)
  - a. Possible error:  
4C–Failed flip motion during Find Home sequence.
29. Calibrate the upward-facing picker tab against upper leadscrew-side sensor. (MMID# 5D, 5E, 3)
  - a. Possible error #1: 62–Optical sensor failed (leadscrew side - near mailslot)
  - b. Possible error #2:  
48–Carriage motion failed during carriage/picker assembly calibration (leadscrew side).
30. Translate to the non-leadscrew side. (MMID# 1, 5, 12, 15, 6)
  - a. Possible error:  
4D–Motion error while checking for a cartridge in the picker
31. Test for a cartridge in the picker. (MMID# 2, 44)
  - a. Possible error:  
4D–Motion error while checking for cartridge in the picker.
32. Initialize the mailslot. (MMID# 2, 3F, 3 B, 3D, 3E)
  - a. Possible error:  
B0–Mailslot will not rotate

## 4.13 Micro-Move Reference Table for Viewing FIND HOME Sequence

Table 4–5 RW514/RW516/RW534/RW536 Micro-Move ID Table

Move ID (hex)	Description
0	No motion; no commands pending
1	Carriage motion; full speed (away from drives)
2	Full speed finger motion
3	Carriage motion ; full speed (toward the drives)
4	Carriage motion; to seat the translate pin (toward the drives)
5	Carriage motion; to seat translate pin (away from drives)
6	Push fingers toward end of picker; during full speed carriage motion (away from drives)
7	Push fingers toward end of picker; during full speed carriage motion (toward drives)
8	First move in flip sequence (picker leadscrew up)
9	First move in flip sequence (picker leadscrew down)
A	Verify flip complete
C	Flip during carriage motion (away from drives)
D	Flip during carriage motion (toward drives)
E	Translate (at bottom)
10	Prepare for carriage motion after translate (leadscrew side; bottom)
11	Prepare for carriage motion after translate (non-leadscrew side; bottom)
12	Translate (at top)
13	Slow motion at top to verify hard stop during translate
14	Prepare for carriage motion after translate (leadscrew side; top)
15	Prepare for carriage motion after translate (non-leadscrew side; top)
16	Move fingers toward storage slot with intent to grab cartridge
17	Detect disk in storage slot before grab and during Initialize Element Status
18	Take up the slack in the fingers before grabbing the cartridge

(continued on next page)

**Table 4–5 (Cont.) RW514/RW516/RW534/RW536 Micro-Move ID Table**

<b>Move ID (hex)</b>	<b>Description</b>
19	Pull cartridge back from storage slot
1A	Push cartridge forward into storage slot
1B	Detect cartridge in storage slot after insert
1C	Pull fingers back from storage slot after releasing cartridge
21	Move fingers toward drive; prepare to grab cartridge
22	Carriage shake; to assist cartridge ejected from the drive to slide into the picker.
23	Move fingers toward drive with intent to grab cartridge
24	Pull cartridge back from drive
25	Insert cartridge into drive until slider engages
26	Move cartridge toward the drive using short steps; look for the drive to accept the cartridge
27	Drive failed to accept the cartridge; pull cartridge back
28	Drive accepted cartridge; release cartridge and pull fingers back
29	Detect a cartridge in the drive with cartridge in the picker
2A	Move cartridge in and out of the picker during test for cartridge in the drive
2B	No motion; waiting for drive to eject the cartridge
2C	Move fingers toward mailslot; with intent to grab the cartridge
2D	Detect cartridge in the mailslot before grab
2E	Take up the slack in the fingers before grabbing the cartridge
2F	Pull cartridge back from the mailslot
30	Carriage motion during mailslot insert
31	Push cartridge forward into the mailslot
32	Carriage motion; during mailslot insert
33	Detect cartridge in the mailslot after insert
34	Pull fingers back from mailslot after releasing cartridge
35	Carriage motion toward actuator arm before pulling mailslot in
36	Rotate the mailslot inward
37	Rotate the mailslot when rotational position unknown

(continued on next page)

**Table 4–5 (Cont.) RW514/RW516/RW534/RW536 Micro-Move ID Table**

<b>Move ID (hex)</b>	<b>Description</b>
38	Verify that rotation of the mailslot inward is complete
39	Release tension on the mailslot rotate arm
3A	Move leadscrew tab toward mailslot actuator arm before pulling mailslot in
3B	Carriage motion toward actuator arm where mailslot is engaged before pushing mailslot out
3C	Rotate the mailslot outward
3D	Verify that the rotation of the mailslot outward is complete
3E	Release tension on the mailslot rotate arm
3F	Move leadscrew tab to mailslot actuator arm before pushing mailslot out
41	Move cartridge in or out during test for a cartridge in storage slot
42	Move fingers in or out during test for a cartridge in storage slot
44	Check for a cartridge in the picker; same motion is used to check for a cartridge in mailslot or storage slot when picker contains a cartridge
45	Insert cartridge into the drive, after slider has engaged
47	Slowly translate at bottom to the non-leadscrew side in the FIND HOME sequence
48	Short carriage motion after finding non-leadscrew side of machine (away from drives)
49	Carriage motion toward drives; looking for hard stop in the FIND HOME sequence
4A	Short carriage motion away from drives after hard stop
4B	Slow carriage motion toward drives; finding room to flip in FIND HOME sequence
4C	Carriage motion away from drives when room to flip is found
4D	Slow carriage motion away from drives; finding room to flip in FIND HOME sequence
4E	Carriage motion toward drives when room to flip is found
4F	Slow flips during FIND HOME sequence
50	Push fingers slowly out of picker after flips in FIND HOME sequence
51	Check for picker short belt in FRU isolation tests

(continued on next page)



**Table 4–5 (Cont.) RW514/RW516/RW534/RW536 Micro-Move ID Table**

<b>Move ID (hex)</b>	<b>Description</b>
56	Carriage motion away from drives to determine which side of picker faces the top
5C	Slow carriage motion away from drives; measuring distance to the top
5D	Long carriage motion during height sensor measurements
5E	Short carriage motion during height sensor measurements
60	Short carriage motion toward drives after finding picker finger position during FIND HOME sequence
62	Slow carriage motion away from drives during error recovery
63	Slow carriage motion toward drives during error recovery
64	Slow carriage motion away from drives during error recovery
65	Slow carriage motion toward drives during error recovery
66	Slow finger or cartridge motion out of picker; used during error recovery
67	Slow finger or cartridge motion into picker; used during error recovery
81	Check for long picker belt in FRU isolation tests
82	No motion; servo-locking the motors

## **4.14 Information Logs**

The logs listed in Table 4–6 are accessible from the control panel by using the INFO option.

**Table 4–6 Information Logs (INFO Logs)**

No.	Log Name	Description
0	Autochanger Error Log	<p>The autochanger maintains a time-stamped history of past diagnostic test errors that have occurred within the autochanger. The error message maintained for each error indicates the failure and the possible Field Replaceable Units (FRUs) that may have caused the failure.</p> <p>Displays as follows:</p> <p style="padding-left: 40px;">Err <i>n y</i> - <i>n</i>th error; actual error code  FRU <i>A</i> - suspect FRU #1  FRU <i>B</i> - suspect FRU #2  FRU <i>C</i> - suspect FRU #3  Test <i>n</i> - test that failed  <i>abcdefgh</i> - time stamp</p>
1	Firmware Version Number	Displays the current autochanger firmware version number.
2	Element Status	<p>Displays the status (empty or full) of the selected autochanger element.</p> <p>Displays three numbers:  First Number = Element number</p> <p style="padding-left: 40px;">0 = picker  1 = drive 1  2 = drive 2  3 = drive 3  4 = drive 4  10 = mailslot  11 - 98 = storage slots (RW514)  11 - 154 = storage slots (RW516)</p> <p>Second Number = Element type</p> <p style="padding-left: 40px;">1 = picker  2 = storage slot  3 = mailslot  4 = drive</p> <p>Third Number = Data mask</p> <p style="padding-left: 40px;">00 = empty  01 = full</p>

(continued on next page)

**Table 4–6 (Cont.) Information Logs (INFO Logs)**

No.	Log Name	Description
3	Software Clock	Displays the current "count" in seconds of the software clock. (hexadecimal)
4	Drive Load Count	Displays the number of cartridge loads for drive 1, 2, 3 or 4.
5	Poweron Hours	Displays the number of hours the unit has been powered on.
	The term <b>Move</b> used in Logs 6 - 10 means SCSI-level moves by the picker mechanism.	
6	Current Move Success Count	Displays the number of successful moves since the most recent autochanger failure.
7	Move Success Average	Displays the average of the values in Log 10 - Move Success Log.
8	Current Move Retry Count	Displays the number of move retries done since the most recent autochanger failure.
9	Total Move Count	Displays the total number of moves and move attempts.
10	Move Success Log	Contains the number of successful moves that have occurred without a failure. Each time a failure occurs, the number of good moves is entered into the log and a new count is started. This INFO display shows the most recent 10 (or less) entries in the log. This log also shows the retry counts corresponding to each log entry.  Example (2 displays for each entity):  1            33482 3  First display: 1 = entry number and 33482 = number of moves Second display: 3 = number of retries
11	Display Runtime Log	Flashes to each display until <span style="border: 1px solid black; padding: 0 2px;">CANCEL</span> is pressed.  A - Moves done B - Retries C - Automatic recoveries D - Hard errors

(continued on next page)

**Table 4–6 (Cont.) Information Logs (INFO Logs)**

No.	Log Name	Description
12	Display Flip Count	Displays total number of picker flips.
13	Display Translate Count	Displays total number of picker translates.
14	Display Mailslot Rotation Count	Displays total number of mailslot rotations.
15	Number of Drives	Displays the number of disk drives in the unit.
16	Drive #1 SCSI Address	Displays drive #1's SCSI address.
17	Drive #2 SCSI Address	Displays drive #2's SCSI address.
18	Drive #3 SCSI Address	Displays drive #3's SCSI address.
19	Drive #4 SCSI Address	Displays drive #4's SCSI address.
20	Sensor Height	Displays the measured height of the picker sensor. (hexadecimal)
21	Picker Cone Angle	Displays the measured picker cone angle from the nominal position. (hexadecimal) The cone angle is the sum of the upward droop on one side of the picker plus the downward droop on the other side of the picker.
22	Stack Tilt	Displays the measured stack tilt of the box. (hexadecimal) The height of each side of the autochanger, or "stack", is the height of each of the two sensors. Tilt is the measure of the difference of the heights of the sides.
23 - 41	Minimum Clearance	Minimum clearance for cartidge insertion into a magazine or mailslot. Up/down clearance is as calculated by Test 65 and Test 67. Up clearance/down clearance (hexadecimal) Example: 00DC 0028 = 220, 40 FFEC 0014 = -20, 20 Note: The autochanger contains either 11 or 18 magazines, depending on the option ordered.
23	Mailslot	

(continued on next page)

**Table 4–6 (Cont.) Information Logs (INFO Logs)**

<b>No.</b>	<b>Log Name</b>	<b>Description</b>
24	Magazine 1	
25	Magazine 2	
26	Magazine 3	
27	Magazine 4	
28	Magazine 5	
29	Magazine 6	
30	Magazine 7	
31	Magazine 8	
32	Magazine 9	
33	Magazine 10	
34	Magazine 11	
35	Magazine 12	
36	Magazine 13	
37	Magazine 14	
38	Magazine 15	
39	Magazine 16	
40	Magazine 17	
41	Magazine 18	



# 5

---

## Removal and Replacement

### 5.1 Field-Replaceable Assemblies

The optical disk library contains the following major assemblies:

- multifunction optical drive mechanism
- mailslot assembly
- power supply
- front panel assembly
- leadscrew assembly
- picker/carriage assembly
- autochanger controller

### 5.2 ESD Precautions

The optical disk library contains very sensitive electrical components. It is **EXTREMELY IMPORTANT** that you follow the proper procedures for preventing ESD (Electrostatic Discharge). Use wrist-grounding straps, anti-static mats, and anti-static work stations when removing and replacing the major assemblies.

---

#### CAUTION

---

Failure to follow proper procedures could lead to intermittent failures and/or premature hard failures in the disk controller and mechanism.

---

## 5.3 Tools Required

The following tools are needed to service the optical library:

- #1 and #2 Pozidriv® magnetized screwdrivers
- T-10, T-15, T-20 and T-25 Torx® drivers
- 5/32 hex wrench (ball tip, at least 4 inches long)—front door
- 1/8 hex wrench (ball tip, at least 6 inches long)—picker motor
- diagonal cutting pliers
- needle-nosed pliers
- flatblade screwdriver

## 5.4 Assembly/Disassembly Procedures

---

### CAUTION

---

Do not press the optical disk library system operation switch or unplug the AC power cord until you are sure that the SCSI bus is inactive. Either pressing the operation switch or unplugging the power cord when the SCSI bus is active can cause data loss and/or indeterminate bus states. (Check the host system reference manuals for information on checking the status of the SCSI bus.)

Opening the rear cabinet door automatically removes power to the optical disk library system motors. When the rear cabinet door is open, disks that are already in a drive can be read; however, if the host issues an autochanger command to access a disk not currently in the drive, an error condition, or host "hang" results.

---

### CAUTION

---

If you will be working on or around the disk magazines, record the slot location and orientation of each cartridge to make sure that the disks can be restored to their original positions if moved.

Always return disks to their original slot and orientation before returning control back to the customer. Serious loss of system integrity will result if this practice is not followed.

---



## 5.4.1 Service Access

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### WARNING

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DO NOT disassemble the drive mechanisms. The magneto-optical drive mechanisms in the library system become Class 3B laser mechanisms when disassembled. If a drive is disassembled, exposure to the invisible laser beam and hazardous invisible laser radiation could result in blindness.

---

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### Note

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A drive that has been disassembled will not be accepted as an exchange assembly.

---

### 5.4.1.1 Opening the Rear Door

*Requires a service key*

---

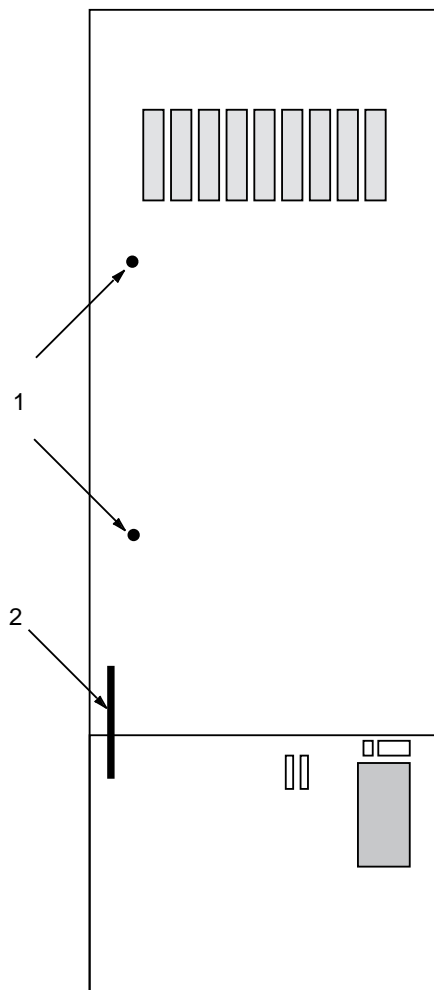
### Note

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The rear door may be secured with a lock added by the customer . You may have to contact the system administrator to remove the lock.

---

**Figure 5-1 Rear Panel Keyholes and Locking Bracket**



1. SEE CAUTION AT BEGINING OF CHAPTER.
2. Remove power from the autochanger by switching off the operation switch and then unplugging the optical disk library from line power.
3. Request that the customer remove the lock on the rear door (if necessary). See Figure 5-1 (1) for the location of the lock bracket.

4. Open the rear door using an access key. Each of the two latches have to be turned approximately 1/2 turn counterclockwise (Figure 5-1 (2)).

---

**Note**

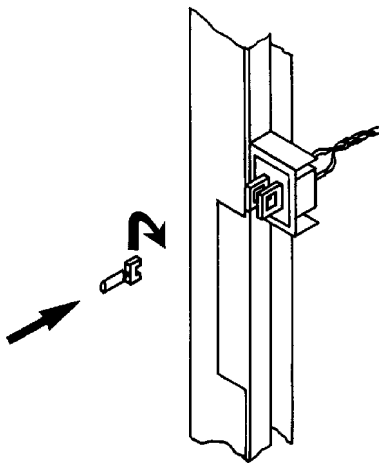
---

Opening the rear door removes power from the carriage/picker mechanism of the library system because the door safety interlock switch is opened.

---

5. If you need power applied to the optical disk library while having the rear door opened, depress the interlock button and insert a pencil or tool (C1705-6078) into the mechanism as shown in Figure 5-2.

**Figure 5-2 Door Interlock Button**



---

**WARNING**

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While working inside the unit with the interlock activated, remove the power cord.

---

---

**CAUTION**

---

When power is removed, the carriage/picker drifts down toward the bottom of the rails. As it drifts down, the picker fingers extend and finally catch on either the edge of a cartridge or the edge of a storage slot.

When the picker fingers are supported this way, it is possible to damage them if the carriage is struck during service.

You can allow the picker/carriage assembly to slide all the way to the bottom of the rails (and out of your way) by pulling the picker leadscrew back and then moving the carriage down. The picker flips once as you move it down, but this is normal.

---

#### 5.4.1.2 Removing the Rear Door

1. Pull the release pin on the top hinge down (you do not have to pull it all the way out, just far enough to clear the hinge). It is held in place by a spring-loaded ball on the end of the pin. You may want to jiggle the pin a little as you pull down to decrease the force necessary to pull it out.
2. Raise the door slightly and tilt it away from you until the door clears the hinge, then lift it up and remove it.

---

**Note**

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The plastic bushing on the lower hinge may become dislodged and fall out when you remove the door.

Be sure to replace this bushing before replacing the door.

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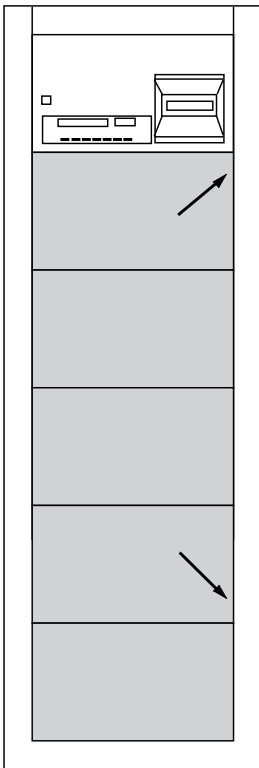
### 5.4.1.3 Opening the Front Door

*Requires a long, 5/32-inch hex wrench.*

Loosen the front panel latches by turning them counterclockwise. It may take several turns to release the spring-tensioned latch.

- the top latch is behind the TOP hole
- the bottom latch is behind the BOTTOM hole of the second panel up from the bottom (Figure 5-3).

**Figure 5-3 Front Door Latch Holes**

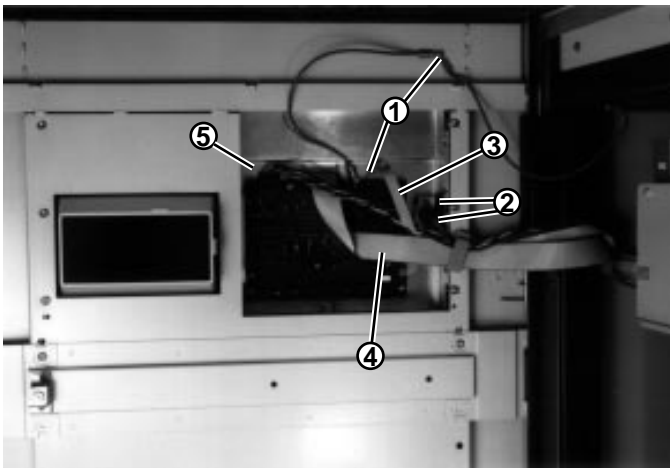


#### 5.4.1.4 Removing the Front Panel PCA

*Requires a T-15 driver.*

1. Remove power from the optical disk library by switching off the operation switch and then unplugging the optical disk library from line power.
2. Open the front door (see Section 5.4.1.3).
3. Disconnect the ground cable. (Figure 5-4, (1)).
4. Disconnect the RS-232 cable, the address cable, and the PCA power cable (Figure 5-4, (3),(4),(5)).
5. Remove the two screws holding the plastic shield and remove the shield (Figure 5-4, (2)).
6. Remove the remaining three screws that mount the PCA to the front door.

**Figure 5-4 Front Panel PCA Mounting**

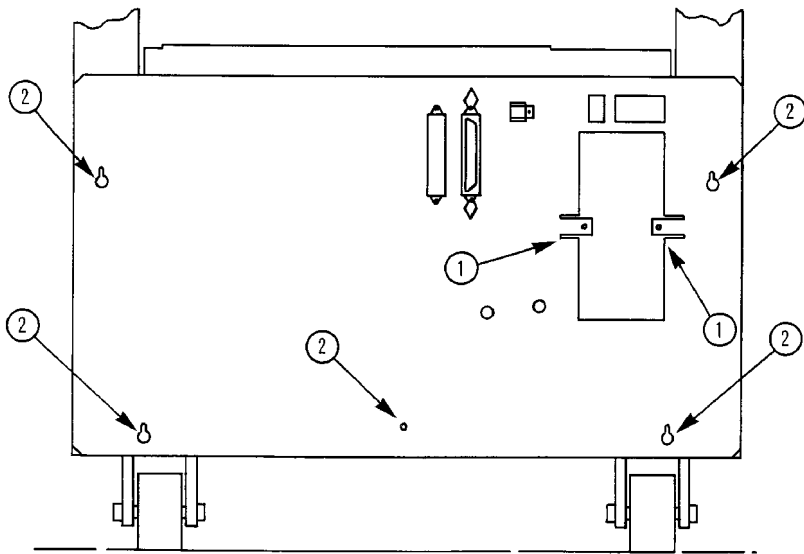


### **5.4.1.5 Removing the Lower Rear Panel**

*Requires T-15 and T-25 drivers*

1. Remove power from the optical disk library by switching off the operation switch and then unplugging the optical disk library from line power.
2. Remove the external SCSI cable(s) and the external UPS cable, if present.
3. Remove the electronics shield.
  - a. Loosen the two screws in the keyhole openings on the electronics shield.
  - b. Remove the remaining two screws.
  - c. Lift off the electronics shield.
4. Remove the flat SCSI ribbon cable from the top connector on the controller board.
5. Remove the red and black power cable from the SCSI repeater PCA and the cable clamp. (See Figure 5-6, (2) in the next procedure).
6. Remove the internal UPS cable from the interconnect board at the front of the autochanger. Unlatch the three cable clamps that route the cable to the lower rear panel, and remove the UPS cable from the clamps.
7. Remove the two screws that hold the lower rear panel to the Power Supply (Figure 5-5, (1)).
8. Loosen the five screws in the keyholes around the perimeter of the lower rear panel (Figure 5-5, (2)).
9. Lift the panel up and away.

Figure 5-5 Lower Rear Panel



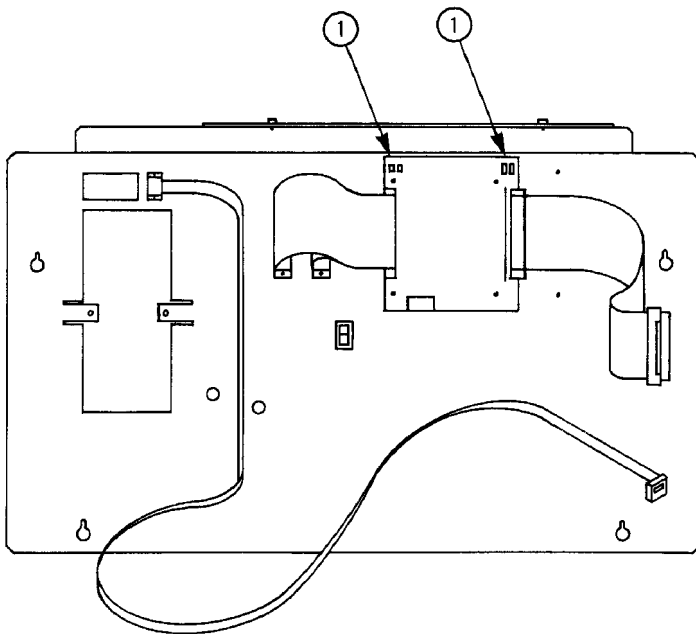


## 5.4.2 Removing the SCSI Repeater PCA

*Requires a T-15 driver.*

1. Remove the lower rear panel as explained in Section 5.4.1.5.
2. Remove the 4 screws that hold the PCA onto the rear panel.

**Figure 5-6 Lower Rear Panel and SCSI Repeater PCA**



---

### Note

If you have to remove the internal UPS cable, use a T-10 driver to remove the two screws.

Make sure the termination jumpers on a replacement SCSI repeater PCA match the settings on the PCA just removed. The location of the jumpers is shown in Figure 5-6, (1).

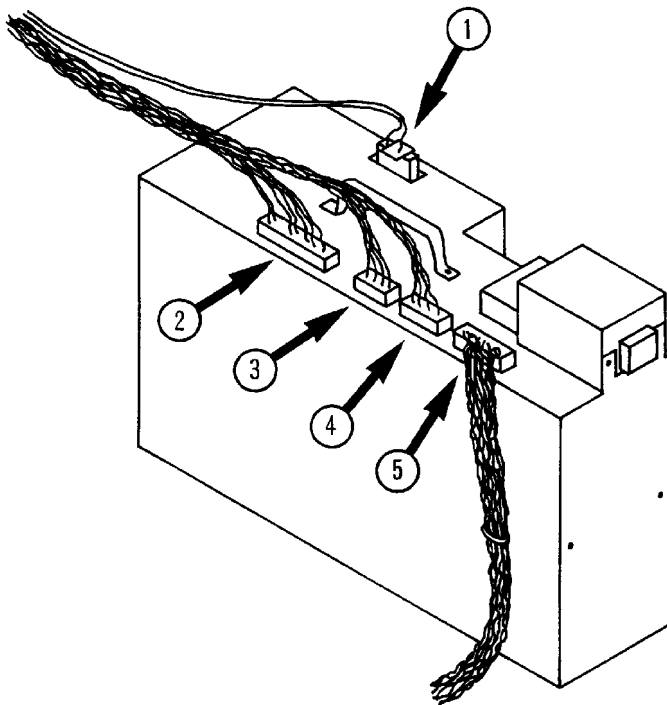
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### 5.4.3 Removing the Power Supply

*Requires a T-15 driver.*

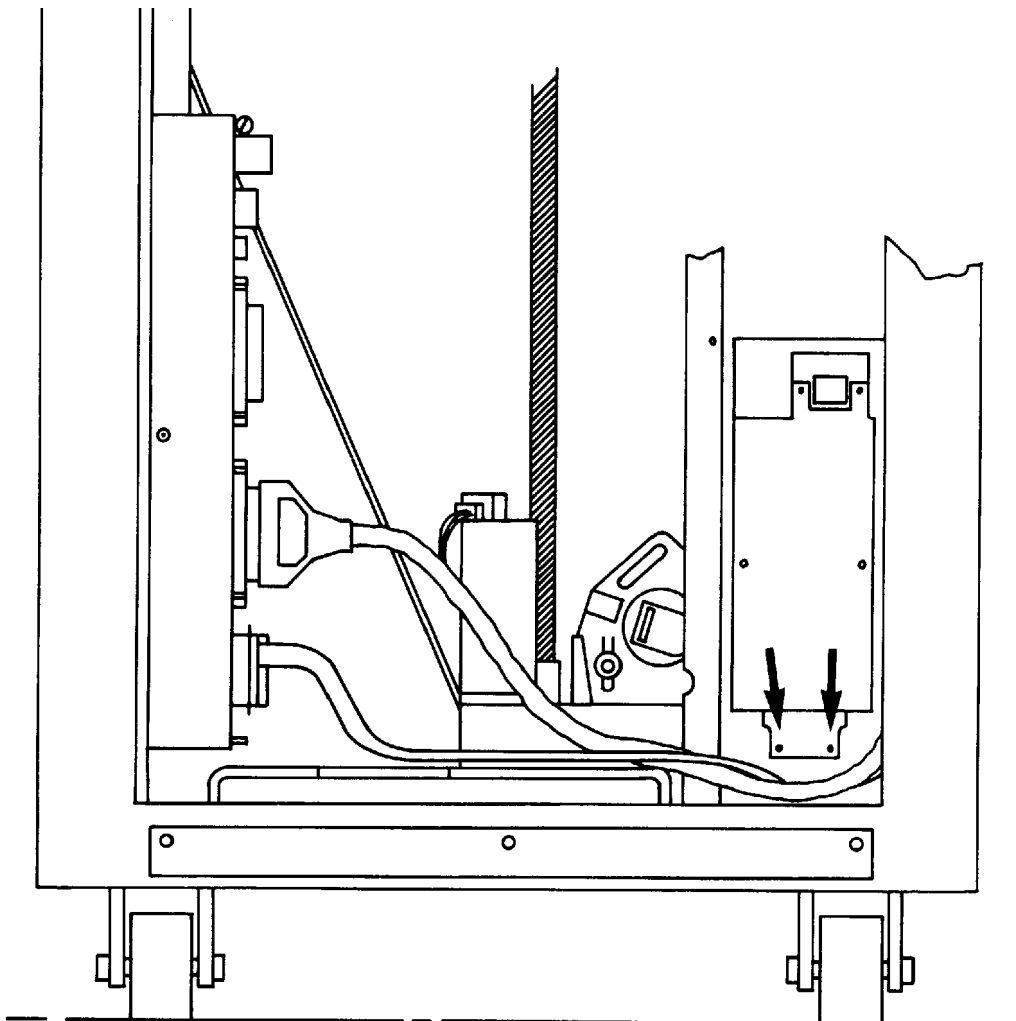
1. Remove the lower rear panel. (See Section 5.4.1.5.)
2. Remove the five cables to the power supply (Figure 5-7, (1) to (5)).

**Figure 5-7 Power Supply Connections**



3. Remove the two power supply mounting screws (Figure 5-8).

**Figure 5-8 Power Supply Mounting Screws**



4. Lift the power supply out using the handle shown in Figure 5-7.

#### 5.4.4 Removing the Leadscrew Motor

Requires a T-25 driver and 1/8 hex wrench.

---

**CAUTION**

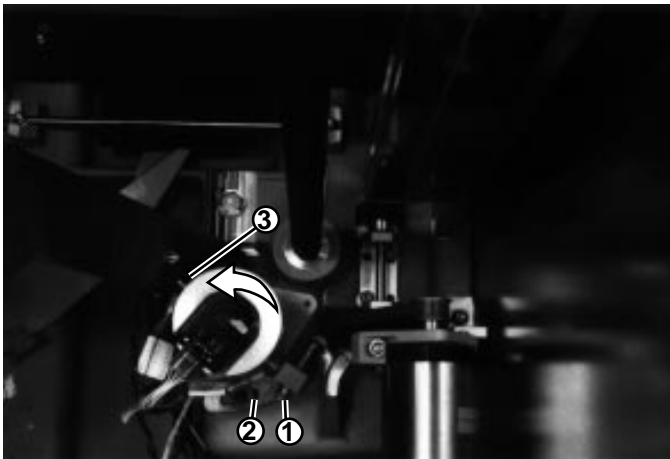
---

DO NOT CHANGE THE POSITION OF THE FACTORY-SET SPRING-LOADED TENSION ADJUST SCREW (Figure 5-9, (1)).

---

1. Remove the 3 cables connected to the leadscrew motor.
2. Remove the leadscrew belt tension on the leadscrew motor.
  - a. Loosen the T-25 Torx screw on the leadscrew motor (Figure 5-9, (2))
  - b. Loosen the 1/8 hex pivot screw on the leadscrew motor (Figure 5-9, (3))
  - c. While rotating the leadscrew motor against its tension spring, slip the leadscrew belt off the pulley on the leadscrew motor.

Figure 5-9 Leadscrew Motor Mounting and Leadscrew Belt



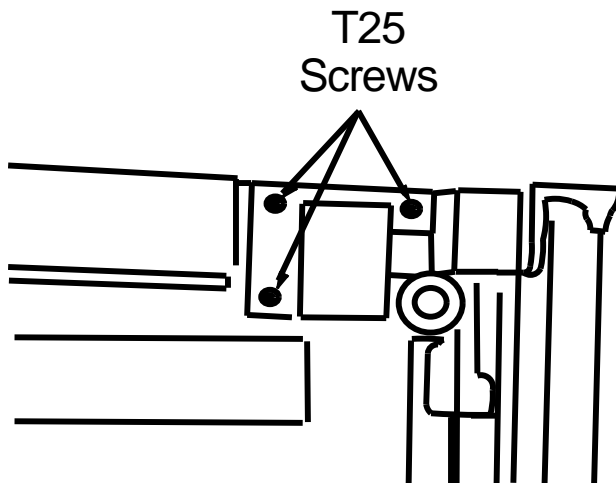
3. Remove the leadscrew motor:
  - a. Remove the T-25 screw (with washer), on the leadscrew motor.
  - b. Remove the 1/8 hex screw on the leadscrew motor.
  - c. Remove the leadscrew motor.

### 5.4.5 Removing the Leadscrew/Leadscrew Motor Drive Belt

*Requires T-15 and T-25 drivers and 1/8 hex wrench.*

1. Remove the leadscrew motor (see Section 5.4.4.)
2. Remove the leadscrew:
  - a. Remove the two T-15 screws holding the leadscrew nut to the carriage bracket.
  - b. Remove the three T-25 screws holding the top leadscrew mounting bracket. (Figure 5-10)
3. Free the top leadscrew mounting bracket by pushing it down slightly (it is spring-loaded) and then pulling it away from the frame. The leadscrew assembly may then be pulled up and out of the lower bearing assembly.

**Figure 5-10 Leadscrew Top Bracket Mounting**



**Note**

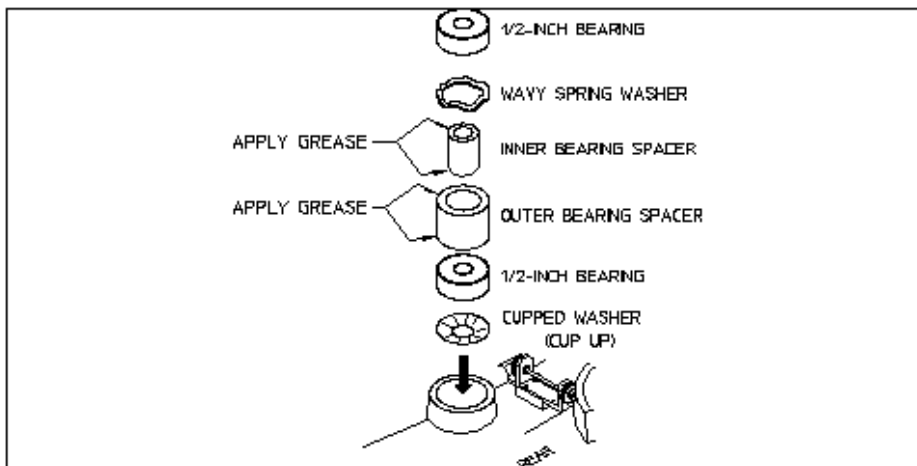
When you reconnect the power cables to the motor, make sure you connect black to black and red to red.

If you are going to replace the leadscrew bearing components, refer to Figure 5-11.

If you are going to replace the leadscrew motor belt, install the new belt and reassemble.

---

**Figure 5-11 Leadscrew Lower Bearing Assembly**

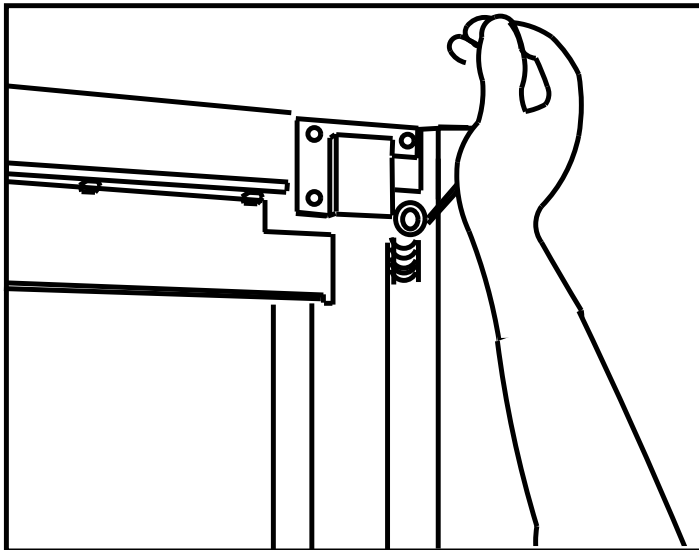


### 5.4.6 Removing the Picker Motor and/or Picker Motor Drive Belts

*Requires a T-25 driver and 1/8 hex wrench. The 1/8 hex wrench should be at least 6 inches long.*

1. Detension and remove the long picker belt (Figure 5–12).

**Figure 5–12 Applying Pressure to Detension the Long Picker Belt**



Insert a screwdriver UNDER the belt and press the tension release plate down. When the screwdriver is placed under the belt, you have enough room to remove the belt while holding the tension release plate down.

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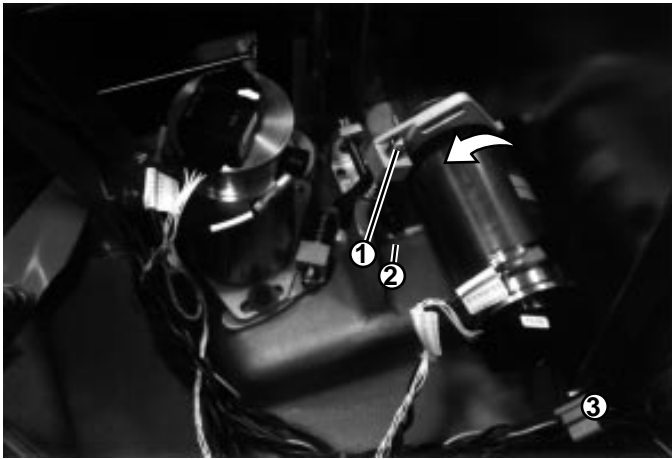
**CAUTION**

---

DO NOT CHANGE THE POSITION OF THE FACTORY-SET SPRING-LOADED TENSION ADJUST SCREW (Figure 5–13, (1)).

---

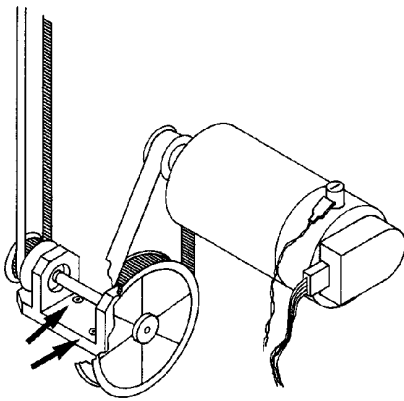
**Figure 5-13 Picker Motor Mounting**



2. Remove the 3 cables connected to the leadscrew motor.
3. Loosen the T-25 Torx screw on the picker motor mount (Figure 5-13, (2)).
4. Loosen the 1/8 hex pivot screw on the picker motor mount (Figure 5-13, (3)). Insert a long (at least 6-inch) wrench through the cutout in the frame.
5. While rotating the picker motor counterclockwise against the tension spring, slip the picker motor drive belt off the shaft pulley.  
If you are going to remove the picker motor drive belt –
6. Remove the two T-25 screws from the lower pulley assembly and remove the assembly (Figure 5-14).
7. Remove the drive belt.



**Figure 5-14 Picker Belt Transfer Assembly and Mounting Screws**



---

**Note**

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When you replace the dual pulley, thread the long belt underneath the small pulley and wrap the picker drive belt around the large pulley. Be sure the picker drive belt does not get caught under the plate when you tighten down the plate.

---

### 5.4.7 Removing the Carriage/Picker Assembly

*Requires a T-15 and a T-25 driver, and a 7/64 hex wrench.*

1. Position the carriage somewhere near the middle of the magazine stack.
2. If possible, pull out an optical cartridge a short distance to act as a temporary rest. The picker also may be supported by a screwdriver, etc. placed in the magazine stack.
3. Detension the long picker belt.
4. Remove the two T-15 screws holding the carriage to the leadscrew mounting bracket. (These two screws were sealed with Loctite®.)

---

**Note**

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Let the leadscrew mounting bracket assembly drift down to the bottom of the leadscrew.

---

5. Remove the leadscrew. See Section 5.4.5.
6. Remove the carriage assembly from the rails.
  - a. Using a 7/64 hex wrench, remove the top and bottom bearing blocks on the right side of the carriage (leadscrew side).
  - b. Rotate the carriage assembly horizontally and pull it through the rails.

### 5.4.8 Removing the Sensor Transmitter PCA

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**Note**

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Be careful not to drop parts into the bottom of the autochanger during this procedure. The screws, plastic cover, and PCA can easily be dropped if you are not careful.

---

*Requires a T-25 driver.*

1. Loosen the four screws on the plastic cover.
2. Remove the plastic cover.
3. Remove all connections to the PCA.
  - 2 optical sensor cables

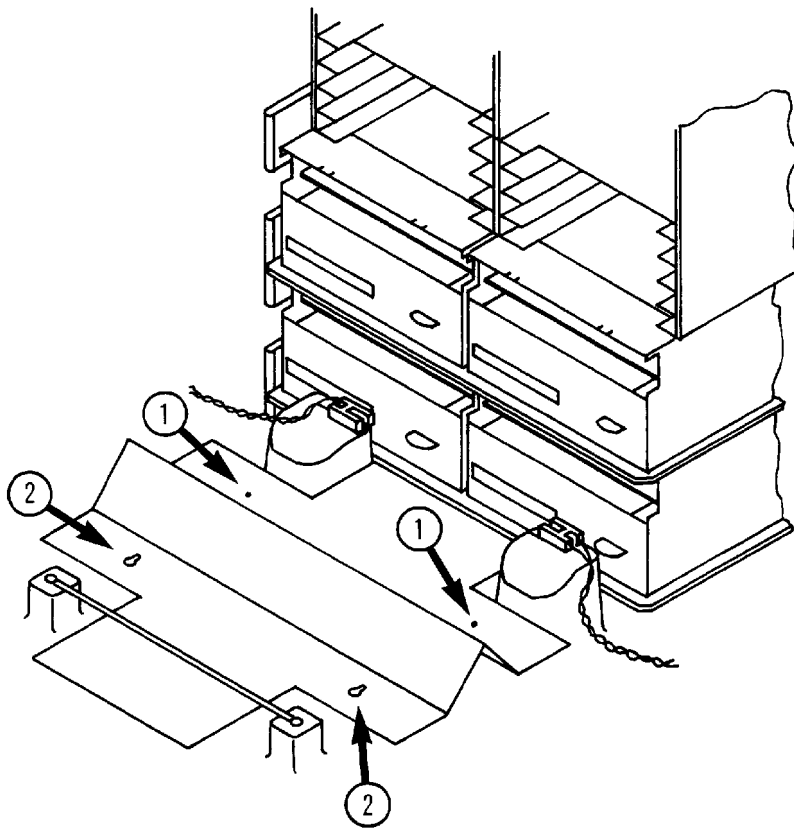
- 1 mailslot cable
  - 1 transmitter cable (ribbon cable)
4. Loosen the screw in the slot edge of the PCA (the edge closest to you).
  5. Remove the two screws holding the PCA to the top casting and remove the PCA.

#### **5.4.9 Removing the Sensor Receiver PCA**

*Requires a T-25 driver.*

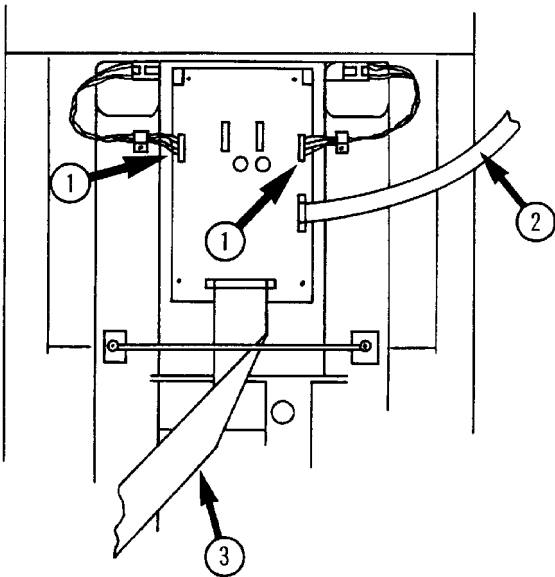
1. Remove the cover.
  - a. Remove the two screws holding the rear of the cover (nearest the drives). See Figure 5-15, (1).
  - b. Loosen the two screws holding the front of the cover in keyholes (Figure 5-15, (2)).
  - c. Slide the cover toward you and lift it away.

Figure 5-15 Sensor Receiver PCA Cover



2. Disconnect all cables to the PCA (Figure 5-16, (1) to (3))
  - 2 optical sensor cables (#1)
  - 1 transmitter cable (small ribbon cable) (#2)
  - 1 interconnect cable (larger ribbon cable) (#3)
3. Remove the four screws holding the PCA to the casting.

**Figure 5–16 Connections to the Sensor Receiver PCA**

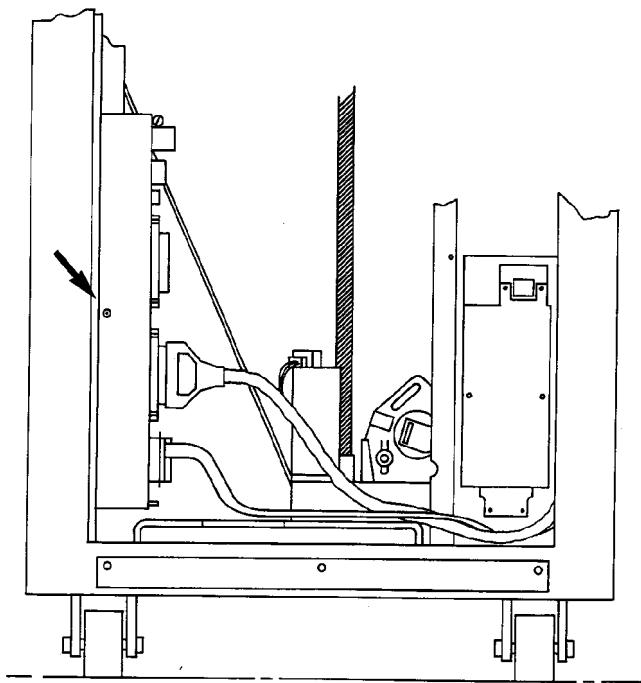


#### **5.4.10 Removing the Autochanger Controller PCA**

*Requires a T-25 driver.*

1. Access this PCA by following the procedures in Section 5.4.1.1 and Section 5.4.1.5.
2. Remove all cables connected to the autochanger controller PCA.
3. Remove the screw holding the metal PCA mounting plate to the frame (Figure 5–17). Slide the PCA away from the frame.

**Figure 5–17 Autochanger Controller PCA Mounting**



4. Verify that the dip switches on the new autochanger controller PCA are set as shown in \*\*\*new figure, new tables\*\*\*.

---

**Note**

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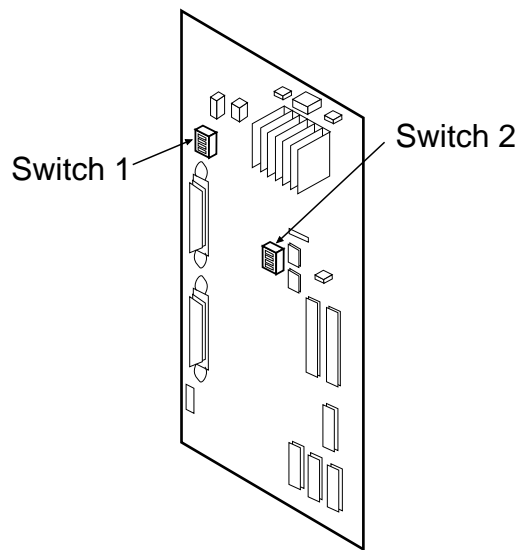
The non-volatile RAM on the autochanger controller PCA **MUST BE INITIALIZED** after firmware is changed or a new PCA is installed.

- set the default configurations—run CONF 16; “CLEAR” option
- cycle power
- initialize the status of the elements—run Test 10

See Section 5.5.1 for the values that are affected by CONF 16.

---

**Figure 5–18 Dip Switch Locations on the Autochanger Controller PCA**



M-2264-6

**Table 5–1 S1 Switch Settings**

Position	Description	Default
1	SCSI Address Switch 1 (LSB) must be set to the default setting to avoid conflict with front panel address selection.	OFF
2	SCSI Address Switch 2 must be set to the default setting to avoid conflict with front panel address selection.	OFF
3	SCSI Address Switch 3 (MSB) must be set to the default setting to avoid conflict with front panel address selection.	OFF
4	Defines RS-232 output as either front panel control or extended error information output. Only the default setting is supported.	OFF

**Table 5–2 S2 Switch Settings**

<b>Position</b>	<b>Description</b>	<b>Default</b>
1	If set to ON, configurations are cleared at each power up (equivalent to setting configuration 16).	OFF
2	Disables PLL synch monitoring. Switch 2 must be set to the default setting for normal operation.	OFF
3	Causes motors to lock at power on, preventing the find home sequence to run. First move attempt after power on will fail. Switch 2 must be set to the default setting.	OFF
4	When set in conjunction with switch 1, clears configurations 16 and 18.	OFF

---

**Note**

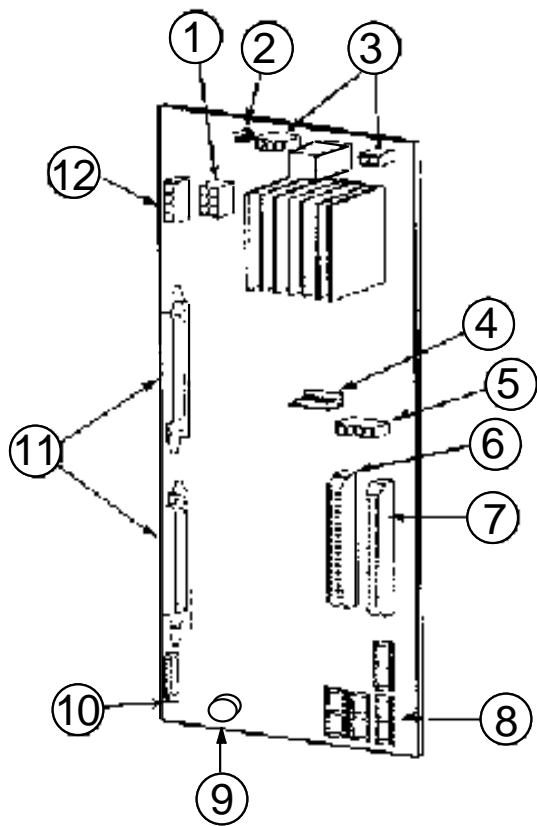
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Switches 1 and 2 are for factory use only and must remain in the default settings.

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Figure 5-19 Autochanger PCA Connectors/Components



Connector/Component #	Connector/Component #
1 power in	7 to interconnect PCA
2 to door interlock	8 ROM sockets
3 motor control (power)	9 lithium battery
4 motor control (functions)	10 RS-232 to control panel
5 power in	11 single-ended SCSI connector

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Connector/Component #	Connector/Component #
<b>6</b> to sensor receiver PCA	<b>12</b> cooling fan power

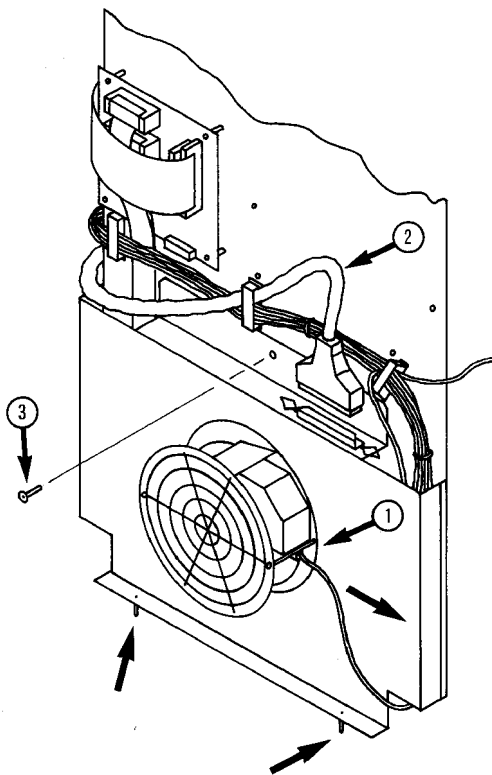
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### 5.4.11 Removing the Cooling Fan Assembly

*Requires a T-25 driver.*

1. Remove the fan power cord (Figure 5–20, (1)).
2. Remove the shielded SCSI cable (Figure 5–20, (2)).
3. Remove the screw at the top of the fan plate (Figure 5–20, (3)).
4. Pull back and then lift up.
5. Disconnect the SCSI ribbon cable connected to all drives. (See Figure 5–21, (1).)
6. Remove the fan mounting plate along with the fan.

**Figure 5-20 Cooling Fan Panel Mounting**



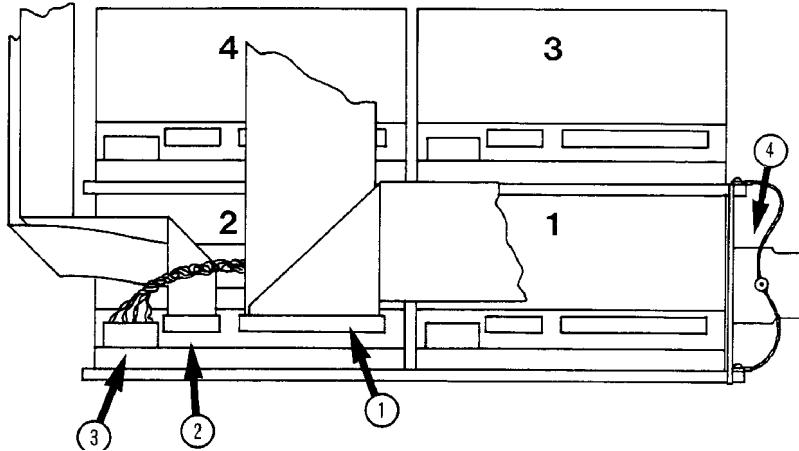
### **5.4.12 Removing the Optical Drives**

*Requires T-10 and T-25 drivers.*

1. Follow the steps in Section 5.4.11 to removing the cooling fan assembly.
2. Remove the drive power and interface cables from the drives on the drive tray that you want to remove. Stow them out of the way. See Figure 5-21, (2), (3).
  - interface cable (#2)

- power cable (#3)

Figure 5-21 Drive Cabling and Mounting on the Drive Tray



3. Remove the two T-25 screws that are in the brackets that secure the drive trays (1 bracket on each side of the trays). (Figure 5-21, (4)).
4. Pull the drive tray(s) out.

---

**Note**

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If there is a cartridge in the optical drive, remove it by inserting the eject tool (C1708-88803) in the hole on the front of the drive, turning it clockwise until the cartridge ejects. For instructions, refer to Section 4.4. For tool order information, refer to Appendix B.

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5. Turn the drive tray over (drives down) and use a T-10 screwdriver to remove the four screws that hold the drive(s) you are changing.

### 5.4.13 Removing the Optical Sensors

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**Note**

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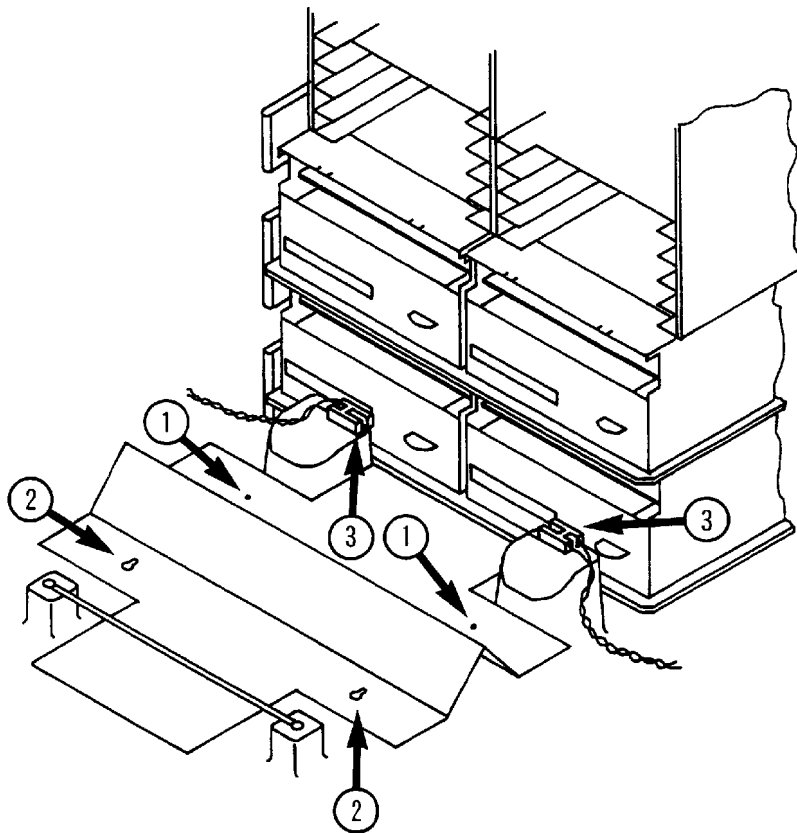
If the picker is in the way, raise the carriage to the middle of the magazine stack, then pull out an optical cartridge a short distance so the picker can rest on the cartridge. The picker also may be supported by a screwdriver, etc. placed in the magazine stack.

---

*Requires a T-15 and a T-25 driver.*

1. Remove the black lower shield:
  - a. Remove the two T-25 screws closest to the sensors (Figure 5-22, (1)).
  - b. Loosen the other two screws in the keyholes on the shield. (Figure 5-22, (2))
  - c. Slide the shield to the rear and lift up to remove it.
2. Remove the screw holding the sensor to the casting (Figure 5-22, (3)).
3. Pull the sensor out. Note the positioning tab on the bottom of the sensor. On re-assembly, this tab and the mounting screw line up the sensor on the casting.

Figure 5-22 Optical Sensors



#### 5.4.14 Removing the Mailslot Assembly

*Requires T-25 and T-20 drivers.*

1. Remove the T-25 screws that mount the cover panel.
2. Remove the mailslot assembly mounting screws.
3. Loosen the T-25 mounting screws on the plastic cover for the Sensor Transmitter PCA. Remove the plastic cover. See Section 5.4.8 for a full description.
4. Remove the T-20 screw from the mailslot sensor cable holder.

5. Remove the mailslot sensor connector from the sensor transmitter PCA.

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**Note**

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It is possible for loose cables to be caught by the mailslot actuator arm. When re-installing the cables in the area of the actuator arm, clip the mailslot sensor cable and the optical sensor cable together in the clip provided on the top casting. Then push the cables up into the slot in the casting above where the mailslot actuator arm comes out.

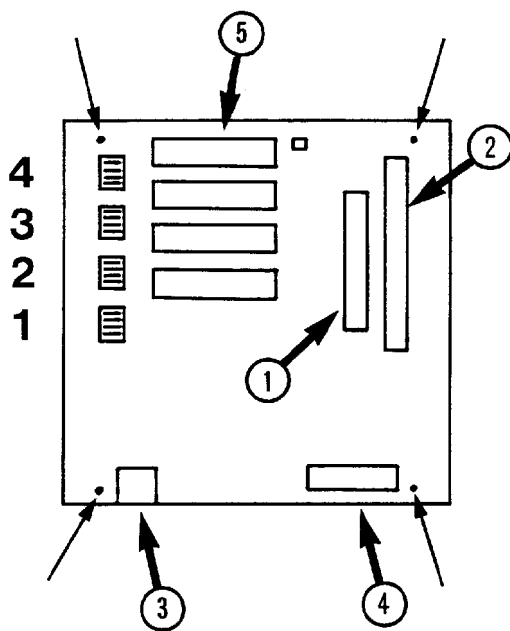
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#### **5.4.15 Removing the Interconnect PCA**

*Requires a T-15 driver.*

1. Remove the two ribbon cables connected vertically on the PCA. (Figure 5–23, (1,2))
2. Remove the UPS cable connected near the bottom of the PCA. (Figure 5–23, (3))
3. Remove the power cable. (Figure 5–23, (4))
4. Remove the four drive interface cables (Figure 5–23, (5)). The numbers in the illustration indicate which drive each cable connector is assigned.
5. Remove the four T-15 screws holding the PCA to the frame.

Figure 5-23 Interconnect PCA and Cable Assignments



## 5.5 Re-initializing the Autochanger Controller PCA RAM after Service

All the RAM on the autochanger controller PCA is battery backed and is, therefore, non-volatile. Most of the RAM is initialized to known values at powerup. Variables that are not changed are customer configurations, autochanger logs, autochanger odometers, element status variables, and variables that help the autochanger recover from power failures. These variables are set by Configs 16 and 18.

NVRAM must be re-initialized after replacing the autochanger controller PCA, after changing the autochanger controller PCA firmware, and after adding drive mechanisms.



### 5.5.1 Variables Cleared by Configuration 16

- SCSI address of the autochanger
- Configurable options set to system defaults (ROM-dependent)
  - whether the autochanger should report recovered errors (CONF 27)
  - whether the autochanger should rotate the mailslot inwards when in secure mode (CONF 31)
  - whether the autochanger should automatically initialize element status when cartridges are found in unexpected places (ROM-dependent)
- Drive status variables
  - reported SCSI address of the drive set to system defaults
  - clear the source of the disk in the drive
- RS-232 configuration set to system defaults
  - baud rate = 19,200
  - word length = 8
  - start/stop bits = 1
  - parity = none
- Power fail variables
  - whether the last move was started is set to FALSE
  - clears the state of the last move
- Recovery restore variables set to system defaults
  - maximum number of find home retries = 3
  - maximum number of error recovery retries = 3
  - maximum number of restore retries = 1
- Security variables
  - clears Unit Reserved
  - clears Prevent Media Removal for each SCSI ID
- Element Status variables
  - clears exception bits

- clears element reservations
- Clear autochanger logs
  - clears Error Log (INFO 0)
  - clears Move Success Log (INFO 10)
  - clears Recovery Log
  - clears Runtime Log (INFO 11)
  - clears number of major retries
  - clears number of inline retries
- Clears magazine and mailslot offsets (unused in most units)
- Resets the security code to 0,0,0

### **5.5.2 Variables Cleared by Configuration 18**

- Resets the move odometer to zero (INFO 9)
- Resets the flip odometer to zero (INFO 12)
- Resets the translate odometer to zero (INFO 13)
- Resets the mailslot rotation odometer to zero (INFO 14)
- Resets the number of power-on hours to zero (INFO 5)
- Resets the number of loads to each drive to zero (INFO 4)

## 5.6 Replaceable Parts

### 5.6.1 Recommended Service Kit

The initial recommended service kit for the optical disk library includes the exchange parts list and the non-exchange parts list for stocking at a logistics.

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#### Note

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The "x" in the part numbers listed below represents a number from "0" to "9" depending on the revision of the part. For example, if the part is newly released, the number will be "0". The first time the part is revised, the number will be incremented to a "1"; the second time the part is revised, the number will be incremented to a "2", and so on.

If you are unsure of the current part number, check your parts database for part number information.

---

### 5.6.2 Assemblies

Refer to Figure 5–24 and Figure 5–25 for exploded views of the optical disk library labeled with FRU numbers.

**Table 5–3 Exchange Parts**

FRU Number	Description	HP Part Number	Digital Part Number
1	AC Controller PCA (RW514 only)	C1705-66511‡	29-30099-01
1	AC Controller PCA (RW514 with code)	5063-2707	29-30099-01 †
1	AC Controller PCA (RW516 only)	C1705-66501	29-30525-01
1	AC Controller PCA (RW516 with code)	5063-2709	29-30525-01
20	MF 650-Mbyte drive single-ended SCSI	C1716C-opt728	29-30871-01
20	MF 650-Mbyte drive single-ended SCSI with code	5063-2701	29-30871-01

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†Always order exchange version with code example

‡HP Part numbers containing a 66 as in C1705-66511 are silk screened on the boards, but these translate to order numbers containing a 60 or 69 as in C1705-69511. The 60 or 69 numbers are on the outside of the box that the board is shipped in.

(continued on next page)

**Table 5–3 (Cont.) Exchange Parts**

FRU Number	Description	HP Part Number	Digital Part Number
20	MF 1.3-Gbyte drive	C1716T-opt728	29-31453-01
20	MF 1.3-Gbyte drive	5063-2715	29-31453-01
28	Power supply assembly	C1705-69x28	29-30102-01
40	Carriage assembly with picker	C1705-60x40	29-31077-01

**Table 5–4 Non-exchange Assemblies**

FRU Number	Description	HP Part Number	Digital Part Number
2	Sensor transmitter PCA	C1705-60x02	29-30095-01
3	Sensor receive PCA	C1705-60x03	29-30096-01
4	Interconnect PCA	C1705-60x06	29-30870-01
8	SCSI single-ended PCA	C1708-60x08	29-30874-01
9	SCSI differential PCA	C1708-60x09	29-30873-01
16	Fan	C1705-60x48	29-30116-01
21	Upper leadscrew bearing assembly	C1705-60x31	29-30104-01
22	Front panel PCA	C1705-60x05	29-30098-01
23	Carriage motor assembly	C1705-60x23	29-30100-01
24	Lower leadscrew bearing assembly	C1705-60x33	29-30106-01
25	Picker motor assembly	C1705-60x25	29-30101-01
26	Magazine	C1700-60x26	29-30047-01
28	Power supply assembly	C1705-60x28	29-30102-01
29	Mailslot w/dual sensors	C1705-60x29	29-30103-01
31	Optical sensor	C1700-60x30	29-30033-01
32	Leadscrew assembly	C1705-60x32	29-30105-01
34 <sup>1</sup>	Picker long belt	C1705-60x77	29-30141-01
34 <sup>1</sup>	Picker motor belt	C1705-60x35	29-30108-01

<sup>1</sup>FRU 34 is either the picker long belt or the picker motor belt.

(continued on next page)

**Table 5–4 (Cont.) Non-exchange Assemblies**

<b>FRU Number</b>	<b>Description</b>	<b>HP Part Number</b>	<b>Digital Part Number</b>
35	Carriage motor belt	C1705-60x34	29-30107-01
38	Mailslot door	C1705-60x47	29-30115-01†
39	Spring bearing block assembly	C1700-60x39	29-30040-01
42	Top tensioner assembly	C1705-60x42	29-30112-01
43	Upper shield	C1705-60x46	29-30114-01†
44	Battery	C1705-60x44	†
45	Lower shield	C1705-60x45	29-30113-01†
49	Door interlock switch	C1705-60x49	29-30117-01
50	Door interlock switch cable	C1705-60x50	29-30118-01
51	Internal UPS cable	C1705-60x72	†
52	Module power cable	C1705-60x51	29-30119-01
53	Interconnect power cable	C1705-60x71	†
54	MF drive power cable	C1705-60x73	†
55	SCSI drive cable	C1705-60x91	†
56	Front panel address cable	C1705-60x65	29-30133-01
57	Motor power/encoder cable	C1705-60x58	29-30126-01
58	SCSI AC cable	C1705-60x92	†
59	Interconnect cable	C1705-60x95	†
62	AC/drive I/O cable	C1705-60x93	†
71	Dual mailslot sensor	C1700-60x70	†
75	Carriage assembly belt	C1705-60x75	29-30139-01
76	ESD brush	C1705-60x76	29-30140-01
79	Top panel	C1705-60x79	†
80	Front door	C1705-60x80	†
81	Back Panel	C1705-60x82	†
83	Back door	C1705-60x83	†
84	Front door fillers/vent	C1705-60x84	†

†These parts are not stocked by Digital. Digital Logistics can place P1 orders for these parts directly to Hewlett-Packard.

(continued on next page)

**Table 5–4 (Cont.) Non-exchange Assemblies**

<b>FRU Number</b>	<b>Description</b>	<b>HP Part Number</b>	<b>Digital Part Number</b>
85	Front bezel assembly (RW514 only)	C1705-60x85	†
85	Front bezel assembly (RW516 only)	C1705-60x89	†
86	Magazine guide	C1705-60x86	29-30148-01†
87	Leveling foot	C1705-60x87	29-30149-01†
88	SCSI I/O cableloop	C1705-60x59	29-30127-01
89	RS-232 to front panel cable	C1705-60x64	29-30132-01
90	Front panel power cable	C1705-60x66	29-30134-01
91	Fan power cable	C1705-60x52	29-30120-01
92	Operation switch w/cable	C1705-60x60	29-30128-01
	Front panel ground cable	C1705-60x67	29-30135-01
	Front panel switch	3101-2917	29-30151-01†
	Dual pulley assembly	C1705-60x74	29-30138-01
	Receiver PCA to AC controller cable	C1705-60x69	29-30137-01
	Service key	C1705-60x78	29-30142-01†
	Transmitter PCA to receiver PCA cable	C1705-60x68	29-30136-01
	Loopback connector	88780-60x95	†
	Interconnect Cable	C1705-60057	29-30125-01

†These parts are not stocked by Digital. Digital Logistics can place P1 orders for these parts directly to Hewlett-Packard.

Figure 5-24 Field Replaceable Units (FRUs)—Diagram 1

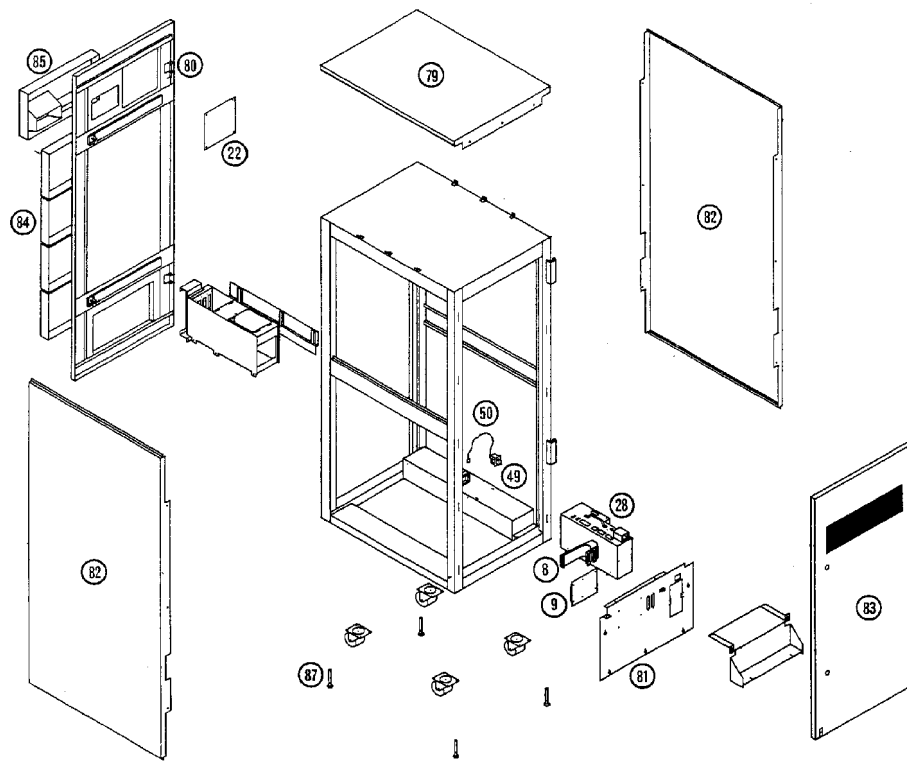


Figure 5-25 Field Replaceable Units (FRUs)—Diagram 2

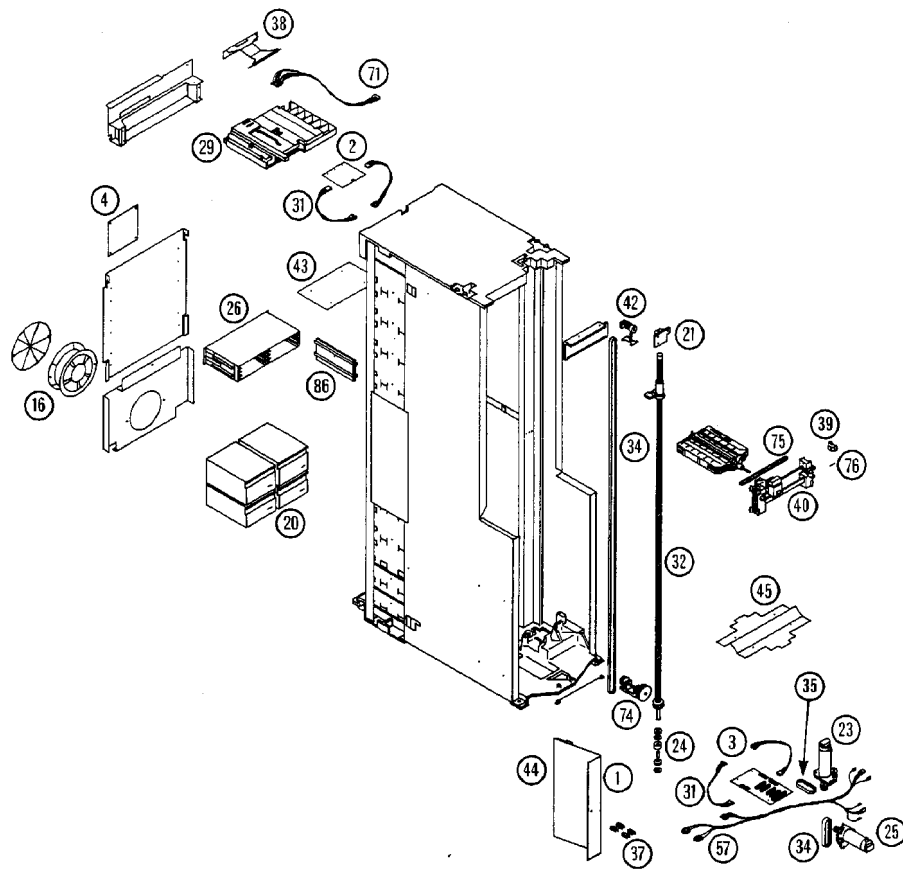




Figure 5-26 Cable Routing—Diagram 1

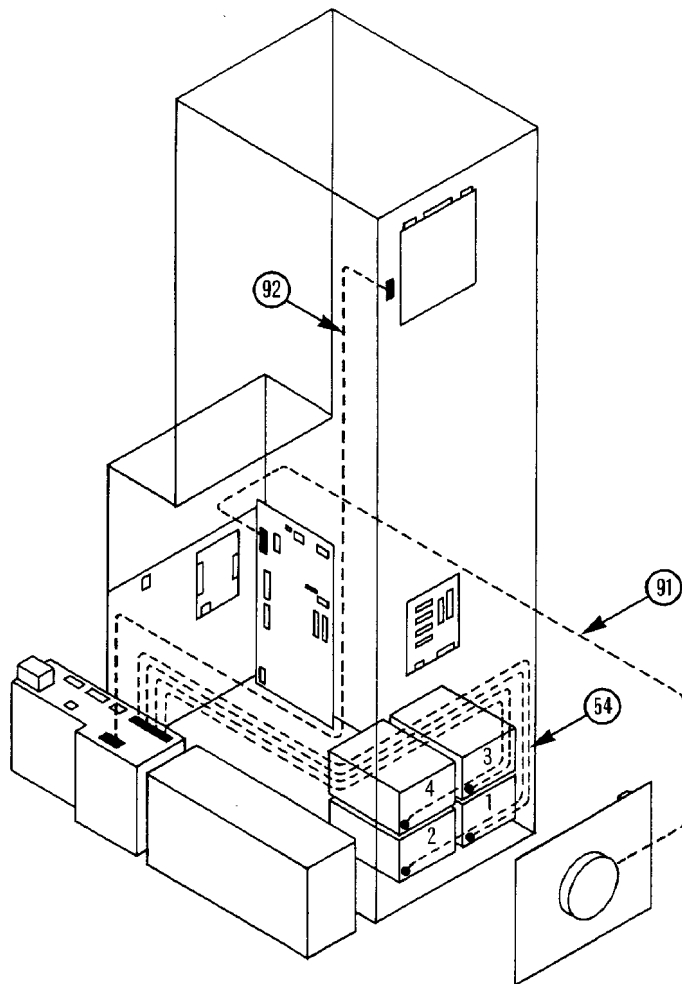


Figure 5-27 Cable Routing—Diagram 2

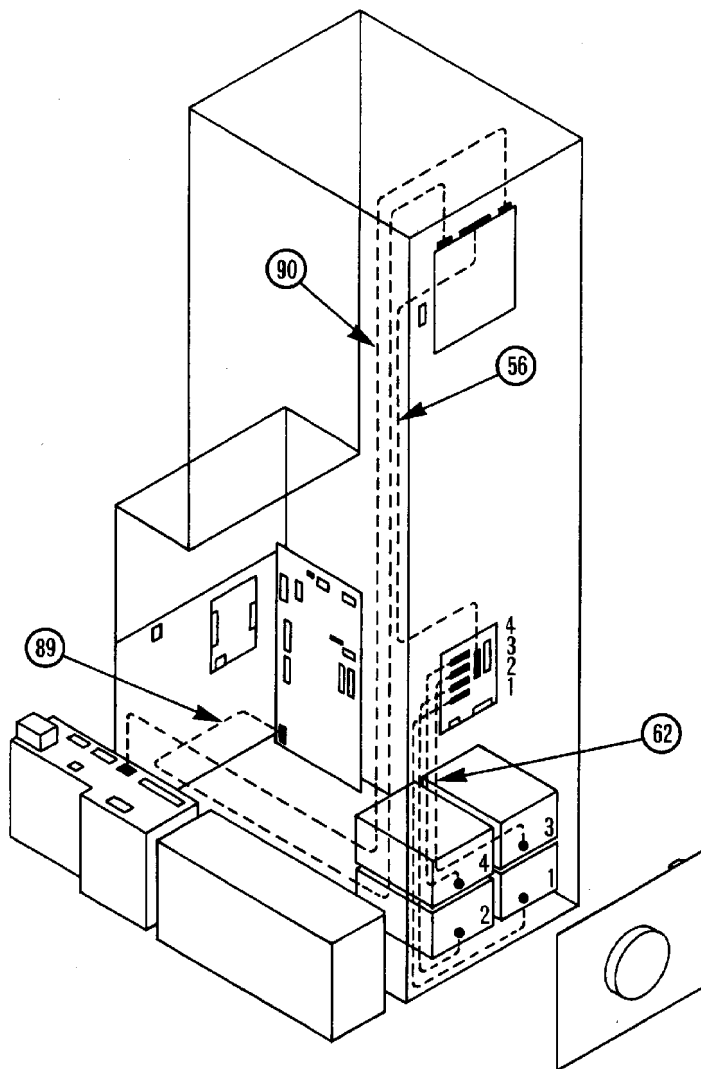


Figure 5-28 Cable Routing—Diagram 3

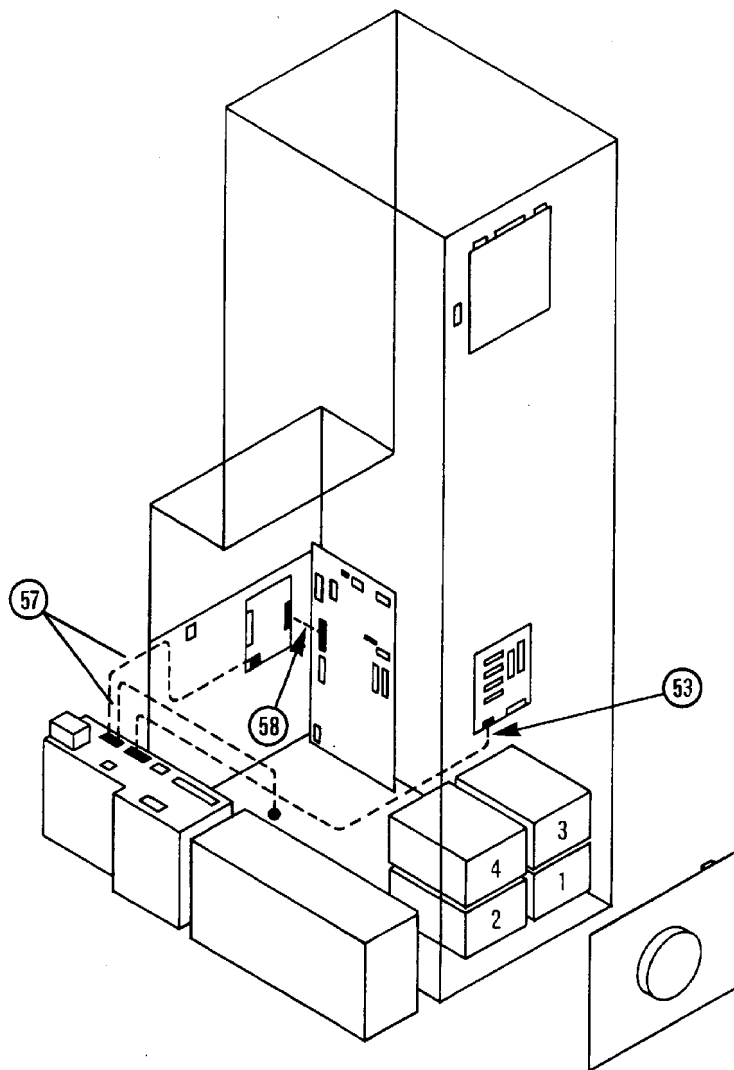
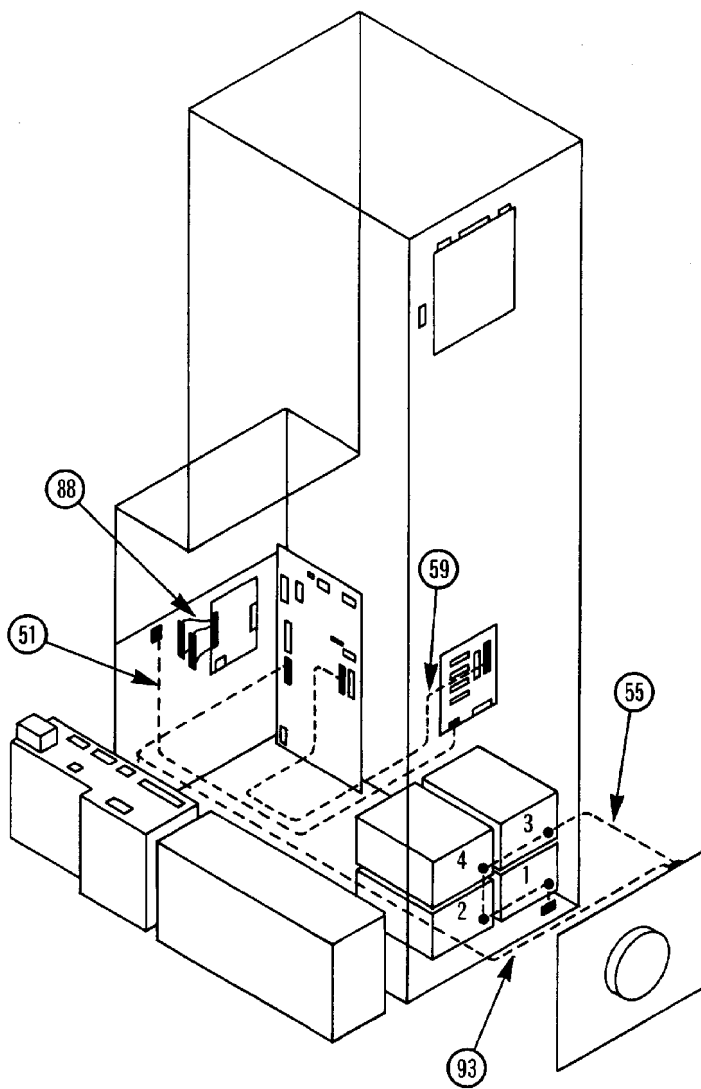


Figure 5-29 Cable Routing—Diagram 4



# 6

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## Theory of Operation

This chapter discusses the following aspects of the optical disk library:

- the autochanger
  - command execution
  - mechanics
- autochanger controller PCA
- power supply
- optical disk drive

In addition, autochanger error detection, diagnostic strategy, and the SCSI interface and command set are discussed.

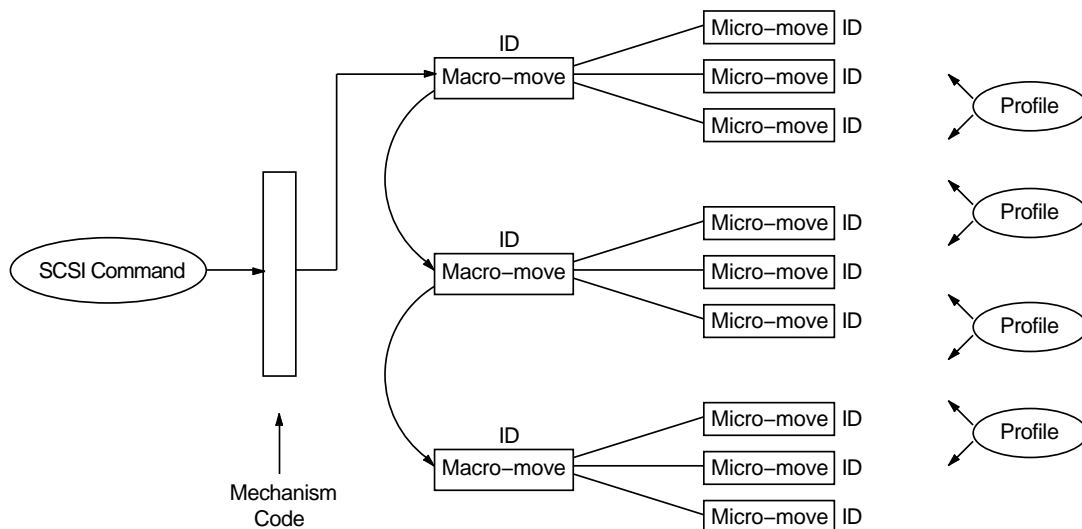
### 6.1 The Autochanger

#### 6.1.1 Movements

The mechanism code of the autochanger accepts high-level SCSI commands from the interface, translates these commands into servo code for the autochanger, executes the command, and reports status.

When a SCSI command is received, it is translated into a series of smaller submoves in the servo code of the autochanger and executed.

**Figure 6–1 SCSI Command Translation for Autochanger Operation**



Examples of high-level commands are:

- Move/Exchange—move a cartridge from element A to element B.
- Seek—position the transport at a target element
- Test—test for the presence of a cartridge at a target element
- Actuate mailslot—rotate the mailslot assembly to perform I/O with the user

The commands are translated into a series of moves which are basic autochanger functions. These submoves are called macro-moves. In this library the macro-moves are as follows.

- move carriage—position the picker transport to a position along the rails.
- flip—rotate the picker
- cartridge I/O—plunge and retrieve the picker finger assembly to move cartridges between the picker and magazines, drives, or the mailslot.
- rotate mailslot—plunge and retrieve the picker finger assembly/leadscrew nut to rotate the mailslot assembly toward and away from the user.

For example. "Move element 11 to element 2 with flip" is transformed into the following sequence of autochanger functions.

1. Determine that element 11 is a storage slot and element 2 is a drive.

2. Move the picker to the front of the storage element.
3. Get the cartridge from the storage element.
4. Do a flip.
5. Move the picker to the front of the disk insertion slot on the drive element.
6. Put the cartridge into the drive element.

The basic autochanger functions (macro-moves) are then divided into a series of smaller movements called "micro-moves." There are two types of micro-moves:

- position move—move the driving motors a given distance at peak speed
- saturation move—same as a position move except that motion is halted if force exceeds a specified threshold.

Position moves are used for high-speed, unobstructed movements of a known distance. Saturation moves are used in low-speed, adaptive movements of variable distance.

Macro-moves consists of one or more combinations of position or saturation type micro-moves. Each macro-move has a tailored set of these submoves to insure that the macro-move will be gentle. As a macro-move is executed, servo gains are adjusted to allow for changes in load characteristics.

An example of the process for a flip is as follows.

1. Move picker finger assembly backwards a fixed distance to engage the flip lock.
2. Change the gain to prepare for upcoming flip.
3. Move the picker finger assembly backwards a fixed distance to trip the mechanism and start the flip.
4. Make sure the flip is completed by doing a saturate on the picker motor until the force exceeds a fixed threshold.
5. Change the gain to prepare for picker finger assembly movement.
6. Move the picker finger assembly forward to relieve the force.

Each micro-move within a specific macro-move has a unique set of stability, performance, error recovery, force, and reliability criteria. Therefore, each micro-move is assigned a unique identification code (ID) which is used to determine how the move should be performed. Before a micro-move is executed, its ID is used to fetch acceleration, velocity and force limits to use. If the move fails, its ID determines the type of error recovery scheme to employ. This tailored technique provides gentle, stable control of the mechanism, resulting in increased reliability.

## 6.2 The Autochanger Mechanism

The mechanics consist of the following major assemblies:

- carriage assembly
- picker assembly (mounted to the carriage assembly)
- mailslot (disk loading and ejecting assembly)
- carriage motor and carriage leadscrew
- picker motor

The carriage/picker assembly is the heart of the mechanism. This assembly positions disks in front of storage slots, drives, and the mailslot. The picker inserts, removes, and flips disks. It also activates the mailslot mechanism.

The carriage has a slot at both ends of a rail that spans the carriage. When the picker is translated to either end, a latch on the picker can enter the slot. When latched at either of these two positions, the picker may be flipped.

The picker may be translated from one side of the carriage to the other when the translate roller contacts the translate bar mounted across either end of the chassis.

The disk insertion slot, referred to as the mailslot, accepts a disk (inserted shutter-end-first) and rotates the disk 180 degrees. This allows the picker to grasp the rear of the disk and insert the disk shutter-end into a drive or storage slot.

The carriage motor rotates the carriage leadscrew, driving the carriage. The motor also monitors the amount of movement with a built-in encoder wheel.

The picker motor provides drive to translate and flip the picker. Power is transferred from the picker motor to the picker assembly by a toothed belt.

## 6.3 The Controller PCA

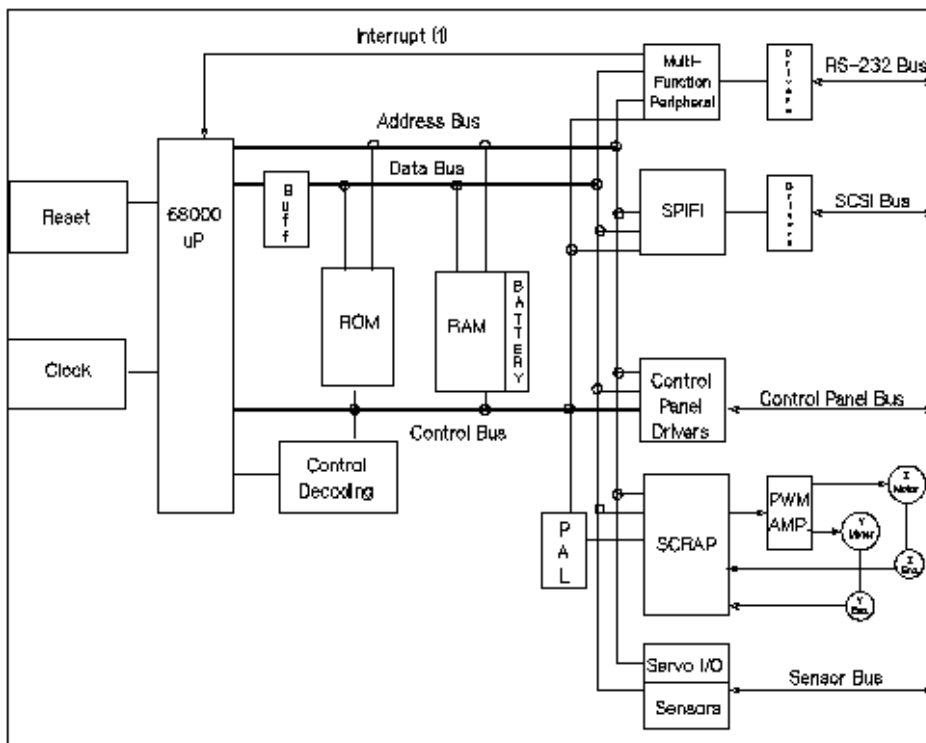
The autochanger controller PCA contains the following major components:

- Microprocessor
- SCRAP chip (interface from digital-to-analog pulse width modulation)
- SPIFI Chip (SCSI bus control)
- ROM
- RAM
- Pulse Width Modulation Amplifier



- Front Panel Control and Filament Drive
- SCSI Interface
- Multi-function Peripheral Chip

Figure 6–2 Autochanger Controller PCA Block Diagram



The microprocessor is a Motorola 68000 running at 12 MHz. This microprocessor controls all processes on the controller PCA such as servos, SCSI interface, and commands to the control panel.

Associated with the microprocessor is clocking circuitry, battery-backed-up RAM, decoding logic, and ROM.

The SCRAP CHIP is the interface between the 68000 processor and the servo system. The SCRAP chip reads the position encoders via Schmitt triggers and uses that information to increment or decrement counters on the chip. The SCRAP chip also provides pulse width modulation (PWM) output signals to drive the motor circuitry.

A programmed array logic interfaces the SCRAP Chip with the 68000 architecture. This PAL generates address strobes, read and write pulses, and a DTACK signal for the 68000. Bus multiplexing is handled through a bidirectional buffer and address buffer.

The SPIFI chip handles the SCSI protocol of the SCSI interface.

ROM. The controller firmware resides in two 128K X 8, 170 ns EEPROMs.

RAM. The two RAM chips are special, low-power CMOS static RAMs. A standby battery on the PCA takes over powering these chips if main power is lost. The chips remain in standby mode, providing a non-volatile memory storage capability on the PCA.

The pulse width modulation (PWM) amplifier takes the signals from the SCRAP chip and changes them into voltages for the picker motor (Z on Figure 6-2) and carriage motor ( Y on Figure 6-2). Motor speed control is by feedback from the picker and carriage motors through Z and Y encoders back to the SCRAP chip.

The front panel display and key pad is controlled by a 8751 microcontroller. This microcontroller sequences and refreshes the vacuum fluorescent display and reads/debounces keystrokes from the keypad.

The vacuum filament display uses a 7.5-volt supply tied to a 5-volt reference resulting in an excitation voltage of from two to three volts. The grids of the display are at approximately 20 volts.

The SCSI interface is basically the SPIFI chip and its associated transceiver. All SCSI protocol is handled by the SPIFI under control of the main 68000 processor. The bus transceiver provides the necessary drive to operate the bus properly.

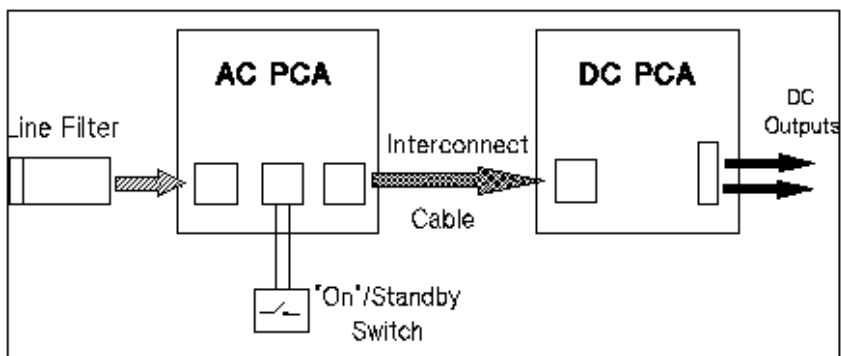
The multifunction peripheral chip controls interrupts, RS-232 functions, and certain timers throughout the controller PCA.

The servo, I/O, and sensors circuitry handle the servo communications (e.g. shutdown control), I/O communications (e.g. drive eject and drive busy), and sensor communications (e.g. mailslot sensor and vertical calibration sensor).

## 6.4 The Power Supply Module

The power supply module consists of an AC PCA and a DC PCA in a distributed power architecture.

Figure 6-3 Overall Diagram of the Power Supply



### 6.4.1 The AC PCA

The AC PCA

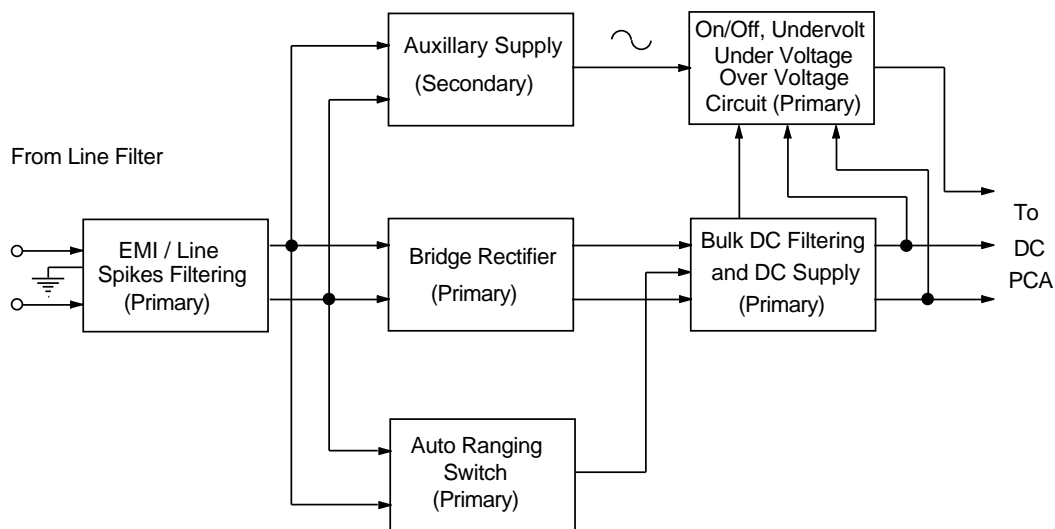
- takes the LINE and NEUTRAL from the site power
- rectifies the AC to DC
- produces a 300 VDC (nominal) crudely-regulated output bus.
- produces an ENABLE signal

The line filter (not shown) - filters some transients and conducted interference noise. This filter is in a box mounted on the top of the power supply cage. This filter also provides a plug for the line input.

The EM/line spike filter block passes the primary and neutral inputs while attenuating noise that the power supply tries to conduct back to the line. The circuit also filters line transients such as high voltage noise, lightning, etc.

This filter, in combination with the line filter, enables the power supply to withstand 6 KV spikes.

**Figure 6–4 The AC PCA in the Power Supply**



The bridge rectifier block takes the sinusoidal ac signal and turns it into pulsating dc voltage. This dc voltage is stored in the bulk filtering capacitors at a nominal value of 300 VDC.

The autoranging switch is a hybrid chip that senses the voltage across the primary. If the voltage is below 145 Vac, the neutral line is connected to the middle of the two bulk filtering capacitors. That, in effect, makes the bridge rectifier/capacitor combination a voltage doubler; enabling a 300-volt output from 120-volt AC input.

If the chip senses more than 145 VAC, the autoranging switch stays out of the circuit and the bridge rectifier passes its output to the bulk DC supply.

This switch supplies the function of a 120/240 switch, automatically correcting for any input.

The on/off and limits block works in parallel with the bulk DC block on the 300 VDC bus. The circuitry here senses the DC voltage on the bus and turns the power modules on the DC PCA on or off according to the operating range needs of the modules.

The DC power modules must have between 200 and 400 volts to operate without damage. While the DC bus is powering up, the limits block keeps the DC power modules off until the voltage level reaches 200. If a surge increases the voltage level to above 400 volts, the DC power modules are turned off to prevent them from being damaged.

The DC power modules may also be turned on or off through the operation switch and the auxiliary supply circuit.

The operation switch is a "Safe Extra-Low Voltage" (SELV) switch on the operator's control panel. In previous products, this switch on the control panel cut primary power, but this switch in the Models 60/100 is on the secondary side, isolated from line potentials through the auxiliary supply block. Placing this switch to on supplies the enable signal to the DC power modules.

The operation switch, in combination with the auxiliary power supply and on/off /limits circuitry, allows the DC power modules to operate if all of the following conditions are met:

- the operation switch is on
- the on/off and limits circuitry senses more than 200 volts on the bulk DC bus
- the on/off and limits circuitry senses less than 400 volts on the bulk DC bus.

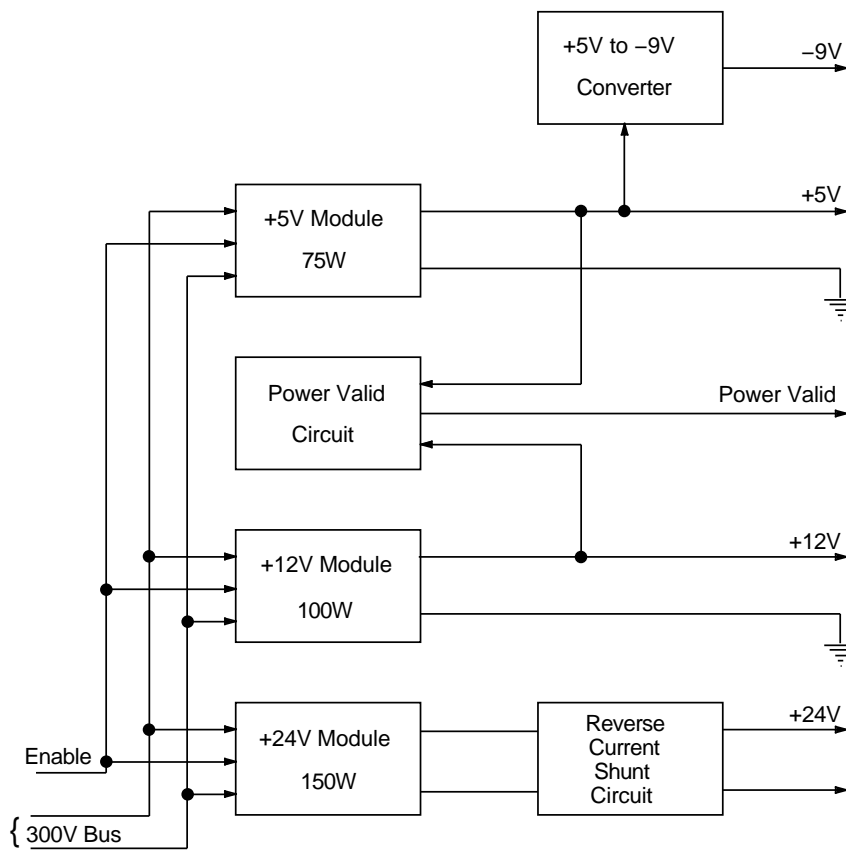
THE AC PCA IS ALWAYS LIVE AS LONG AS THE UNIT IS PLUGGED IN.

#### **6.4.2 The DC PCA**

The DC PCA receives the 300-volt bulk DC input from the AC PCA and converts this to regulated outputs of +5, +12, and +24 volts if the enable signal is present.

Some of the +5 VDC that is generated is fed into a chip that further converts this to +9.5 VDC. This voltage is used to bias some op amps.

**Figure 6-5 The DC PCA in the Power Supply**



The power valid block looks at the +5 V and +12 V outputs. When these outputs rise to operating range (~4.5 V and ~11 V), this circuit triggers a power-on reset.

The reverse current shunt block absorbs any reverse current generated by the autochanger motors as they slow down.

### 6.4.3 Power Supply Specifications

Table 6–1 Input Requirements

	Range
Input Voltage	88 to 137 VAC RMS 176 to 268 VAC RMS
Input frequency	47 to 66 Hertz
Input current	< 9 amperes AC RMS
Input power	< 475 W
Inrush current	< 40.0 amperes peak at cold start
Input fusing	on PCA
Power factor	0.6
Line surge	Steps from 129 to 150 VAC for 500 milliseconds with no failure (including fuse)
Line sag	Steps from 108 to 80 VAC for 500 milliseconds with no failure (including fuse)
Line brownout and recovery	a. Linearly decrease from 90 to 0 VAC in 30 minutes. Then 120 volts is reapplied b. Linearly increase input voltage from 0 to 90 VAC in 30 minutes
Total output power	375 W (sum of all outputs)

## 6.5 The Multifunction Magneto-Optical Drives

There are four major sub-assemblies within the optical drive: the controller printed circuit assembly (PCA), servo printed circuit assembly (PCA), loader mechanism, and the optical head.

### 6.5.1 Controller PCA

The controller PCA is a microprocessor-based collection of digital electronics that handles functions performed by a SCSI controller, a data buffer, and a formatter/sequencer.

#### 6.5.1.1 SCSI Controller

The SCSI controller provides the SCSI interface connection to the host computer. This interface consists of both the electrical signals and the firmware which decodes the various commands and messages on the SCSI bus and instructs the drive to take appropriate action.

### **6.5.1.2 Data Buffer**

The data buffer and associated control electronics provide a buffer to speed match transfers to and from the host computer and the optical disk. The data buffer provides a cache for read and write operations, optimizing the speed of these transfers. The RW514/RW516 data buffer contains 256-Kbytes of buffer RAM; the RW534/RW536 data buffer contains 512-Kbytes of buffer RAM.

### **6.5.1.3 Formatter/Sequencer**

The formatter/sequencer function formats and decodes data for read and write transfers. During a write function user data is sent via the SCSI bus as bytes (8 bits each). The formatter converts these 8 bits of parallel data into an encoded serial bit stream that includes all the format and error correction features required to meet the ANSI and ISO specifications. During reads, the decoder converts the serial data stream, which includes format and error correction features, into parallel data.

## **6.5.2 Servo PCA**

The servo PCA includes a digital signal processor (DSP) that controls the actions of the many servo loops that interact with the optical head and the loader assembly.

### **6.5.2.1 DSP Microprocessor and Support/Servo Control Loops**

Most of the electronics on the servo PCA are analog circuitry. This circuitry is designed into the control loops of the following servos: spindle motor/speed, laser power control, track following, seek/position maintenance, focus actuation, fine position actuation, and coarse position actuation. Whenever the drive is performing a read or write operation, all these servos are activated.

Also on the servo PCA are control electronics for the loader assembly. Included are drivers for the loader and spindle (speed control) motors, sensor circuitry for the cartridge loaded and write protect detectors, LED drivers for the front panel LEDs, and control circuitry for the bias magnet subassembly of the loader mechanism.

### **6.5.2.2 Read and Write Channel Electronics**

Read channel electronics take analog data from the optical head and convert it into digital "transitions." These transitions are decoded by the decoder electronics on the controller PCA in order to extract data from format and error correction features. The write channel electronics take the serial data stream from the formatter/sequencer and convert the digital pulses into analog data. This analog data is then sent to the optical head.



## **6.5.3 Mechanism Assembly**

### **6.5.3.1 Loader Mechanism**

The loader mechanism consists of two motors: a spindle motor for speed control and a loader motor for loading and unloading of the cartridge. The loader motor includes a gear train and rack-and-pinion system that allow the cartridge shuttle to raise and lower the cartridge within the loader housing. The bias magnet subassembly sits on top of the cartridge shuttle and provides the correct polarity for erasing or writing data.

### **6.5.3.2 Optical Head**

A major feature of the optical head is a "split optics" design. This design physically separates the laser diode and its associated detectors from the focus/fine position actuators. This design results in a significant seek time performance advantage due to less mass on the moving portion of the optical head.

There are several actuators in the optical head. The coarse position actuator moves the focus/fine position actuators to the vicinity of the desired sector on the optical disk. The fine actuator makes small corrections ( $\pm 25$  tracks) to center the optical head on the desired sector. The focus actuator then moves up and down to provide optimal focus on the light beam. All these actuators, and the laser diode (and its detectors) are controlled by the servo PCA.

The laser diode and its associated detectors are part of a flex circuit on the optical head assembly. On this flex circuit are analog electronics which further condition the control signals for the laser diode, and pre-amplifiers for the servo and data control signals that are returned to the servo PCA.

## **6.6 Optical Disk Layout and Error Correction**

Two optical disk formats are available. Optical Drives in the RW514/RW516/RW534/RW536 can read from and write to 650-Mbyte optical disks. The RW534/RW536 optical drive can read from and write to both 650-Mbyte and 1.3-Gbyte optical disks. The target's role is to manage the 130mm multifunctional drive and disk as an optical memory device through its SCSI interface. These optical drives support 130mm rewritable optical disks conforming to ISO/IEC 10089 Format A, and write-once optical disks conforming to ISO/IEC DIS 11560, for 650-Mbyte capacity. The RW534/RW536 also supports the ECMA 184 standard for 1.3-Gbyte capacity, both rewritable and write-once.

The following sections outline disk layout for both 650-Mbyte and 1.3-Gbyte optical disks. Throughout this section, the sector number is that of a 1024 bytes/sector disk. The value of a 512-bytes/sector disk is written inside parentheses just after the value for the 1024 bytes/sector disk.

### 6.6.1 Optical Disk Layout—650-Mbyte Capacity

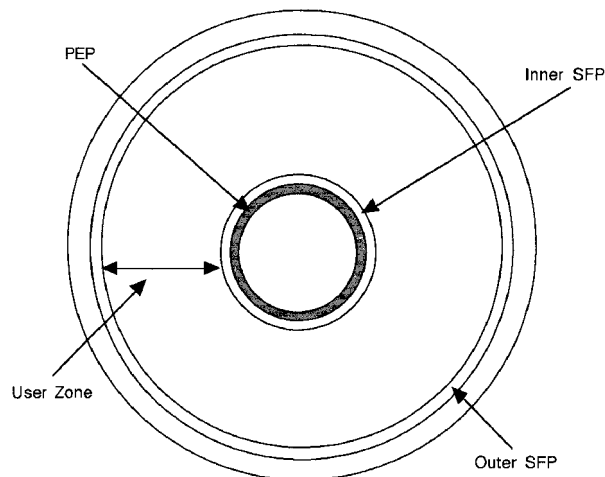
This section highlights some of the aspects of an optical disk as outlined by the ISO standard DIS 10089A and ISO/IEC DIS 11560.

There are three recording styles used on the optical disk that correspond to three specified areas on the disk:

- Phase encoded part (PEP)
- Standard formatted part (SFP)
- User zone

Both the PEP and SFP are areas that have been “recorded” by the media manufacturer and cannot be altered by a drive. They contain information that the drive uses to best read and write to the optical disk. Consult the ISO standard for more information.

Figure 6–6 Optical Disk Layout



## 6.6.2 User Zone Layout—650-Mbyte Capacity

The User Zone consists of Defect Management Areas (DMAs), a User Area and a Slipping Area. The DMAs contain information on the organization of the User Area into User Groups and Spare Groups. The DMAs also contain a Primary Defect List (PDL) and a Secondary Defect List (SDL) that provide information on the locations of defects. The drive uses this information to perform defect management.

Although the User Zone consists of tracks and sectors, it is often easier to think of it in terms of a large memory space of consecutive sectors. Figure 6–7 shows the following parts of the User Zone for 650-Mbyte media.

1. Four Defect Management Areas (DMAs) that each consist of:

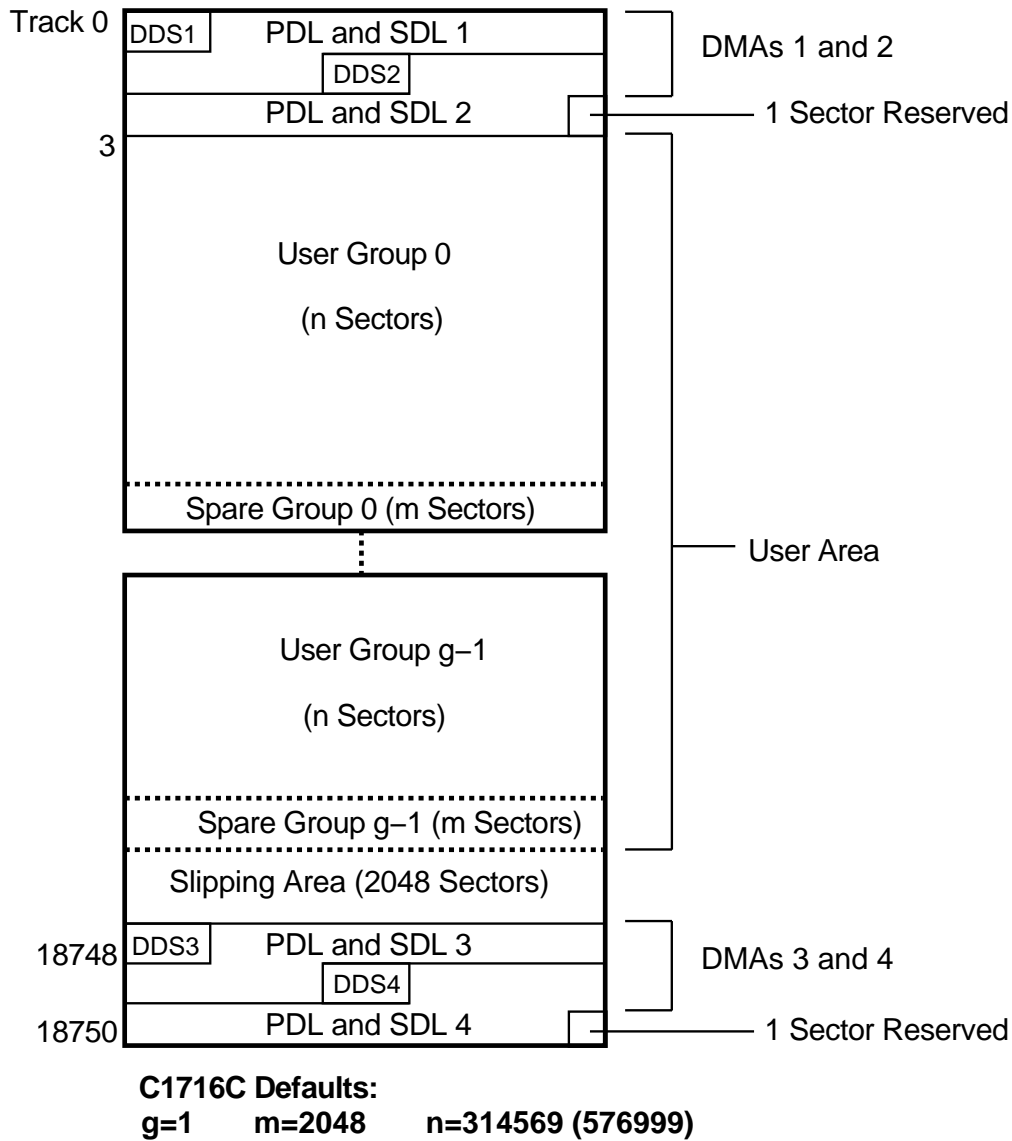
- Disk Definition Structure (DDS)
- Primary Defect List (PDL)
- Secondary Defect List (SDL)

2. Slipping Area

3. User Area that consists of:

- g User Groups, of n sectors each
- g Spare Groups, of m sectors each

**Figure 6-7 User Zone Layout for 650-Mbyte Media**



### 6.6.3 Optical Disk Layout—1.3-Gbyte Capacity

This section highlights some of the aspects of 1.3-Gbyte Capacity optical disks as outlined by ECMA 184.

The disk is divided into various zones, similar to the 650-Mbyte capacity. See Figure 6–6. In addition to the User Zone, where user data is stored, there are other zones including the PEP and SFP zones. Both the PEP and SFP contain information prerecorded by the media manufacturer and cannot be altered by a drive. They contain information about media parameters that the drive uses to read from and write to the optical disk. Consult the ISO standard for more information.

### 6.6.4 User Zone Layout—1.3-Gbyte Capacity

The User Zone consists of Defect Management Area (DMAs), and User Area. The DMAs contain information about the organization of the User Area into User Groups and Spare Groups. The DMAs also contain a Primary Defect List (PDL) and a Secondary Defect List (SDL) that provide information on the locations of defects. The drive uses this information to perform defect management.

Although the User Zone consists of tracks and sectors, it is often easier to think of it in terms of a large memory space of consecutive sectors. Figure 6–8 shows the following parts of the User Zone for 1.3-Gbyte media.

1. Four Defect Management Areas (DMAs) each consisting of a
  - Disk Definition Structure (DDS)
  - Primary Defect List (PDL)
  - Secondary Defect List (SDL)
2. Slipping Area
3. User Area consisting of
  - $g$  User Groups, of  $n$  sectors each
  - $g$  Spare Groups, of  $m$  sectors each

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**Note**

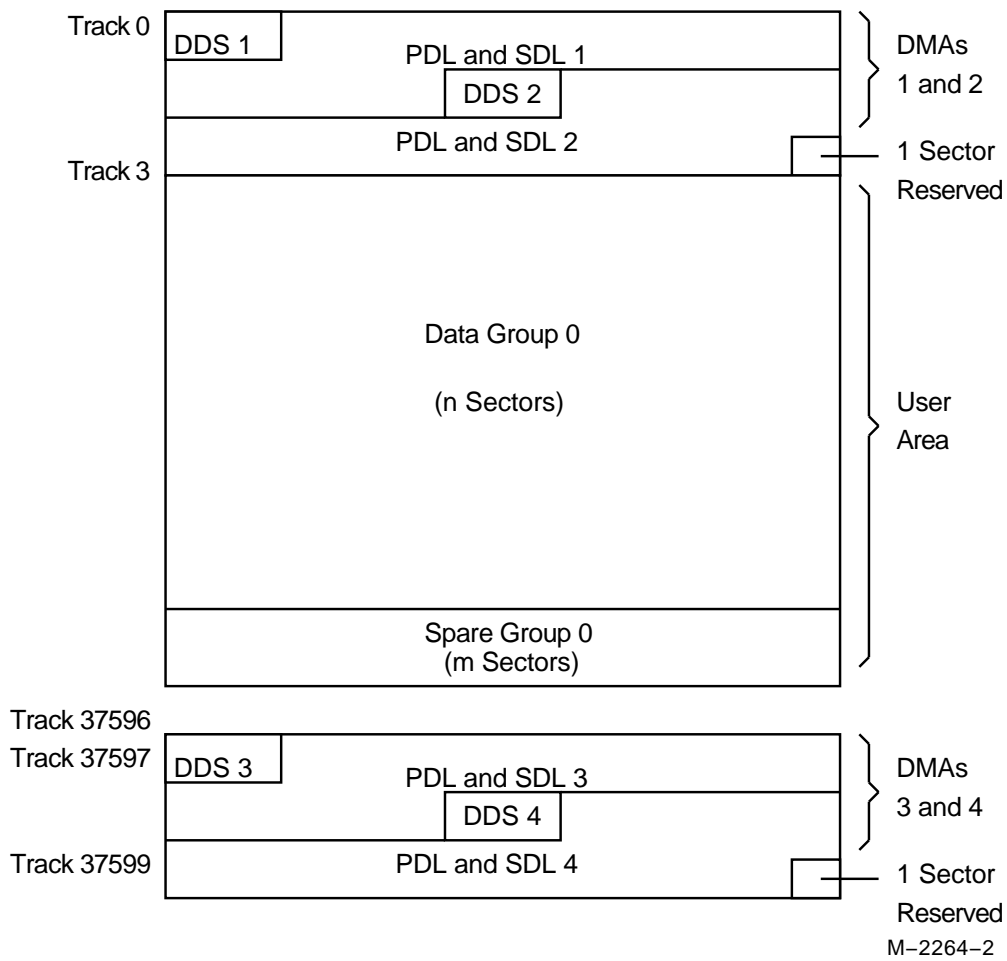
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$g = 1$  or  $16$

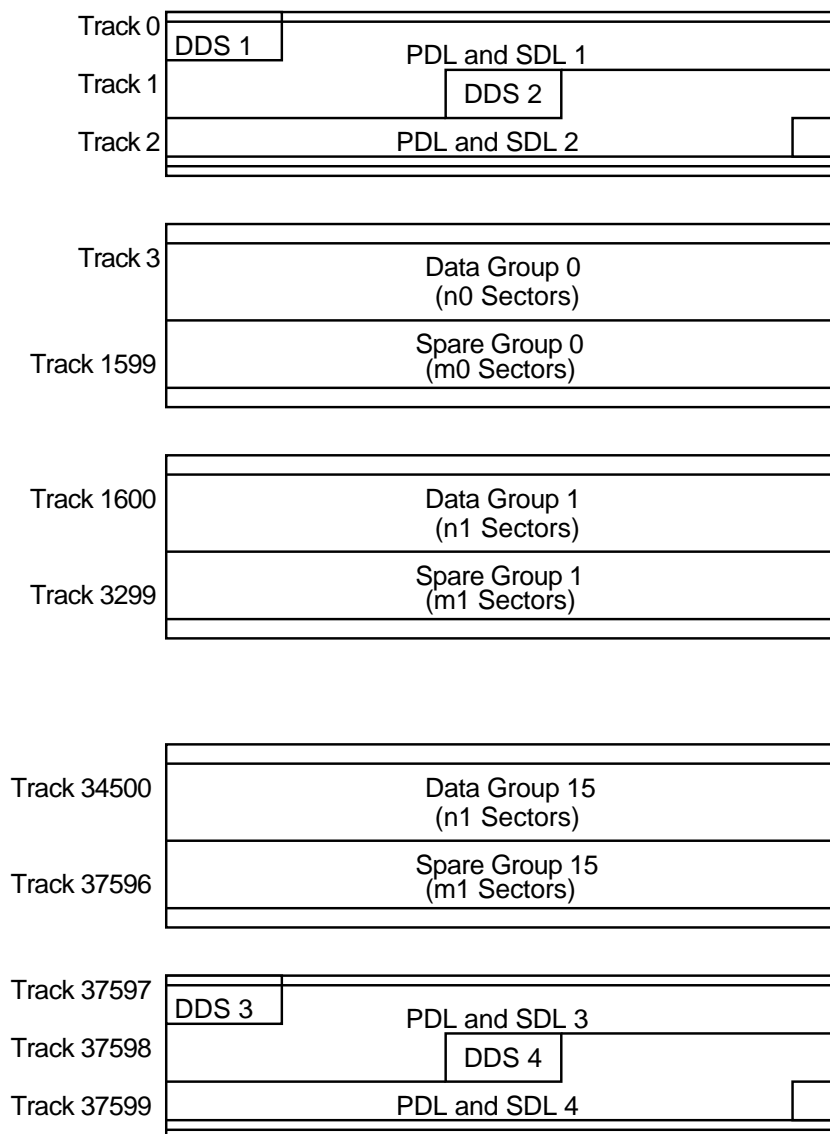
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Figure 6–8 and Figure 6–9 show the User Zone Layout for 1.3-Gbyte, for both  $g=1$  and  $g=16$ , respectively. It is important to note one significant difference between 650-Mbyte and 1.3-Gbyte media. Both types of media can contain multiple groups, however the start of each group on 650-Mbyte media can “slip out” with any slip spares found prior to that group. 1.3-Gbyte media establishes groups BEFORE accounting for slip spares. (Please refer to Section 6.6.5 for more details.)

**Figure 6–8 User Zone Layout for 1.3-Gbyte Media, g=1**



**Figure 6–9 User Zone Layout for 1.3-Gbyte,g=16**



M-2264-1



Table 6–2 shows the values for n and m for 1.3-Gbyte with g=16 (1024 media).

**Table 6–2 Values for n and m for 1.3-Gbyte with g=16 (1024 media)**

<b>Band</b>	<b>n</b>	<b>m</b>
Data Band 0	27064	85
Data Band 1	28815	85
Data Band 2	30498	102
Data Band 3	32198	102
Data Band 4	33898	102
Data Band 5	35581	119
Data Band 6	37281	119
Data Band 7	38981	119
Data Band 8	40664	136
Data Band 9	42364	136
Data Band 10	44064	136
Data Band 11	45747	153
Data Band 12	47447	153
Data Band 13	49147	153
Data Band 14	50830	170
Data Band 15	52462	187

The format of 1.3-Gbyte media is often referred to as a “sliding sector” format. This means that logical tracks do not necessarily align with physical revolutions. Table 6–3 details the physical revolution to logical track layout for 1.3-Gbyte media.

**Table 6–3 Physical Revolution to Logical Track Layout**

<b>Zone or Band</b>	<b>Physical Revolution Range</b>	<b>Logical Track Range</b>
Inner SFP	(-369,-161)	(-369,-161)
Inner Mfg	(-128,-33)	(-128,-33)
Data Band 0	(0,1349)	(0,1599)
Data Band 1	(1350,2699)	(1600,3299)

(continued on next page)

**Table 6–3 (Cont.) Physical Revolution to Logical Track Layout**

<b>Zone or Band</b>	<b>Physical Revolution Range</b>	<b>Logical Track Range</b>
Data Band 2	(2700,4049)	(3300,5099)
Data Band 3	(4050,5399)	(5100,6999)
Data Band 4	(5400,6749)	(7000,8999)
Data Band 5	(6750,8099)	(9000,11099)
Data Band 6	(8100,9449)	(11100,13299)
Data Band 7	(9450,10799)	(13300,15599)
Data Band 8	(10800,12149)	(15600,17999)
Data Band 9	(12150,13499)	(18000,20499)
Data Band 10	(13500,14849)	(20500,23099)
Data Band 11	(14850,16199)	(23100,25799)
Data Band 12	(16200,17549)	(25800,28599)
Data Band 13	(17550,18899)	(28600,31499)
Data Band 14	(18900,20249)	(31500,34499)
Data Band 15	(20250,21599)	(34500,37599)
Outer Mfg	(21600,22949)	(37600,37785)
Outer SFP	(22950,24299)	(37786,38046)

### **6.6.5 Drive Defect Management**

The optical drive mechanism supports the defect management scheme specified by ISO 10089A and ISO DIS 11560, and ECMA 184.

Each DMA consists of a:

- Disk definition structure (DDS)
- Primary defect list (PDL)
- Secondary defect list (SDL).

The DDS contains information on how the disk is organized into user and spare groups. There are three important parameters; the variables *g*, *n*, and *m* are used in the ISO standard, and are here for consistency:

- *g* - number of groups
- *n* - number of sectors in a user group
- *m* - number of sectors in a spare group

User data is stored initially in the sectors of the user group, while the spare groups are reserved sectors for the linear replacement sparing algorithm. The values of *g*, *n*, and *m* are generally chosen so that they maximize the number of spare sectors allowed, and maximize the size of the user area. (The ISO standard for 650-Mbyte media allows for a maximum of 2048 spare sectors total from the PDL and the SDL, while the ECMA standard for 1.3-Gbyte allows for 2057 or 1077, depending on the sector size of 1024 or 512 bytes per sector respectively.) For 1.3-Gbyte the value for *g* must be 1 or 16.

In general for 650-Mbyte:  $g * (n + m) \leq (\text{size of User Area})$

In general for 1.3-Gbyte:  $g = 1 \text{ or } 16$ , (*n*, *m* or *n*<sub>0</sub> thru *n*<sub>15</sub> and *m*<sub>0</sub> thru *m*<sub>15</sub> are predefined based on *g*).

For more details consult the ISO or ECMA standard.

The PDL contains a list of defective sectors determined by the manufacturer or by a certification of the User Area, i.e. during a SCSI Format Unit Command. Defective sectors in the PDL are managed according to the slip sparing algorithm described in this chapter.

The SDL contains a list of defective sectors and corresponding replacement sectors determined during disk use, after certification. Defect/replacement entries in the SDL are managed according to the replacement sparing algorithm described in this chapter.

The Slipping Area is a portion of the user zone used by the slip sparing algorithm. Defects found during certification are excluded from use. The user accessible space is slipped by a corresponding number of sectors into the slip area. This area is large enough to account for a maximum of 2048 slip spares. Any unused sectors in the slipping area are unavailable for user data.

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**Note**

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The slipping area applies only to 650-Mbyte media.

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### 6.6.6 Slip Sparing Algorithm

The slip sparing algorithm maps logical blocks to physical blocks to avoid defective sectors found during a certification process. The list of defective sectors is maintained in the Primary Defect List (PDL). During an address translation, the logical blocks are "slipped" past any defective sectors, thus the name "slip sparing." As an example, say there are defective sectors at block addresses 20 and 30, and you want the physical address of logical block 40. Since addresses 20 and 30 are defective they should be slipped past, so logical block address 20 is now physical block address 21, and logical block address 30 is now physical block address 32, taking into account both physical blocks 20 and 30 being slipped past. This would result in physical block address 42 being the translation for logical block address 40.

Note that this is not a truly accurate example for three reasons:

1. PDL entries are given in track/sector form, not as block addresses. The final translated address must also be in track/sector form.
2. There is a 3-track offset added to the physical block address, 51 sectors for 1024 bytes/sector media and 93 sectors for 512 bytes/sector media.
3. This example does not take into account the effects of Spare Groups preceding this sector. The User and Spare Groups are determined after slip sparing, for 650-Mbyte media, and before slip sparing for 1.3-Gbyte media.

For 650-Mbyte media, slip sparing is always the first step of address translation, followed by User and Spare Grouping, and replacement sparing. For 1.3-Gbyte media, user and Spare Grouping is always the first step of address translation, followed by slip sparing, and replacement sparing.

The data structures for slip sparing and User and Spare Grouping (the PDL and DDS respectively) are created or updated only during a certification/format process, such as during a SCSI Format Unit Command. After certification, any additional defect management updating is done through the replacement sparing algorithm.

### 6.6.7 Replacement Sparing Algorithm

Once a disk has been certified and is being used by a customer, additional defective sectors may develop. The replacement sparing algorithm is intended to manage these defective sectors.

As was mentioned earlier, the DDS allows for a number of sectors to be reserved for future use by the replacement sparing algorithm. These "spare sectors" reside in the Spare Groups, and are referred to via entries in the SDL. Each SDL entry consists of a defect and its replacement pair. The defect is always a sector in a

User Group, and the replacement is a sector from a Spare Group. Both are given in track/sector form.

During normal address translation, after the original physical address is found via the slip sparing algorithm, the SDL is checked to see if that physical address was 'spared' through the replacement sparing algorithm. If so, the replacement physical address is substituted for the original physical address.

In the event a sector needs to be replaced, i.e. due to a Reassign Blocks Command or automatic reallocation during a write command, a new defect/replacement pair is added to the SDL (if the new defects not already in the SDL) or an existing defect/replace is updated (if the new defect is already in the SDL). Updating an existing defect/replacement pair only occurs on 650-Mbyte media. For 1.3-Gbyte media a new defect/replacement pair is added, thus creating a "chain" of defect /replacement pointers.

### **6.6.8 Error Thresholds**

Although not directly related to disk format, the various error thresholds are the basis for deciding whether or not to spare a sector. This could happen during the certification process (i.e. the slip sparing algorithm) or auto-reallocation during a SCSI Write command (i.e. the replacement sparing algorithm). These error thresholds are related to the format of a sector in the user zone.

Each sector in the user zone consists of a header, user data, and parity bytes for error correction. The first error threshold of importance involves information in the sector header. Each header consists of three copies of the sector's track number, sector number, and a Cyclic Redundancy Check (CRC). The error threshold is determined by the number of sectors found "good."

The other error threshold of interest pertains to the degree of error correction required on the data. The error correction code (ECC) used causes parity bytes to be written following the user data. During a data recovery operation, these bytes are used to detect and correct up to 8 defective bytes in an interleave. Each sector has 10 (5) interleaves with 120 (122) bytes in each interleave. The actual number of bytes per interleave requiring correction is used as an error threshold. Consult the ISO standard for more details. Table 6-4 shows the error thresholds for the optical drive. The sector IDs column refers to the minimum number of sector IDs that must be read correctly for the corresponding operation to be deemed successful. The ECC level column refers to the maximum number of bytes per interleave that require correction in order for the corresponding operation to be deemed successful.

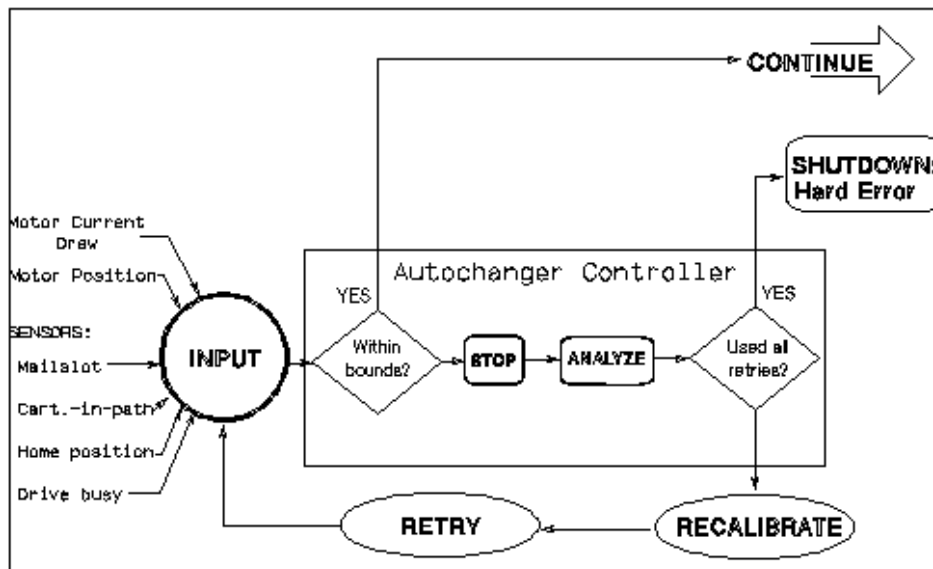
**Table 6–4 Error Thresholds**

Operation	Sector IDs	ECC Level
Format	2	3
Write	2	-
Erase	2	-
Verify	2	4
Read (Recovered)	1	7
Read	1	8

## 6.7 Error Detection and Recovery

Refer to Figure 6–10 during the discussion in the next two sections.

**Figure 6–10 Error Detection and Recovery**



### 6.7.1 Error Detection

The autochanger error detection methods are extensive. Both processes and sensors detect errors.

Each of the processes that detect errors are interrelated. Depending on the error condition, the autochanger expects feedback from one or more of the following processes before a diagnosis is made:

- overforce shutdown
- sense of touch
- motor position

An overforce shutdown occurs when the motors exert more force than is expected or required. If this occurs, the servo automatically shuts itself down to prevent parts damage. After an overforce shutdown occurs, the autochanger analyzes the situation, self-calibrates, and attempts a retry.

Sense of touch is the process where actual force used is compared to the recommended force for each move. The autochanger uses this information to detect errors or qualify moves. The difference between sense of touch and overforce shutdown is that the servo is not automatically shut down if sense of touch detects an error.

The positions of the motors are continuously monitored by the controller PCA. The position, along with the sense of touch feedback, is a valuable source of error detection.

These processes also combine to detect errors. For example, the sense of touch and the motor position processes continuously monitor the motor position and motor force levels to sense whether a potential error has occurred. It does not imply a sensing of complete force profiles, but the ability to continuously sample the force profile.

The physical parts of the error detection system are the sensors. These hard-wired sensors provide information that is impossible to determine through other means. This feedback information is fed to the autochanger controller PCA.

There are two forms of sensors:

- drive handshake - the drive provides a "BUSY" signal back to the autochanger controller to indicate the status of certain loader operations.
- optical sensors - detect conditions that are otherwise difficult to detect and are used to calibrate the unit. There are two mailslot sensors to detect if a cartridge is properly inserted into the mailslot, and a sensor for detecting

which side of the picker faces the mailslot-end of the chassis and allow calibration of the picker's position in relation to the drive and storage slots.

### **6.7.2 Error Recovery Processes**

The autochanger uses the following processes to recover from errors:

- inline recovery
- find home sequence
- calibrate

For certain well-defined error conditions, recovery operations that have little effect on position or performance of the autochanger are executed inline. These are used only if the error condition can be determined exactly, and in cases where further motion may make recovery difficult.

The purpose of FIND HOME is to initialize the machine to a known state. For power-on, this means finding a "home" (zero) position for the carriage/picker assembly.

The calibrate procedure is then called to further locate reference points other than the zero locations found during FIND HOME. Using sensors, the picker is characterized as to its relationship with the mechanism. The positions of the drive, mailslot, and storage slots are calculated based on the location of the sensors.

For recovery after power-on, many subsets of FIND HOME may be called. One mode, for example, only determines which side of the picker faces the mailslot-end of the chassis. If any of the subsets of FIND HOME fail, the full FIND HOME sequence is run. A successful running of FIND HOME gives the autochanger code the exact positions of each end of the carriage rail and the rear plane of the picker assembly. Also, the autochanger then knows which side of the picker is facing the mailslot-end of the chassis and whether the picker holds a disk or not.

### **6.7.3 SCSI Detected Errors**

For the vast majority of potential error conditions that may exist, the SCSI interface retrieves immediate information about the error with no motion required. Potential error conditions include:

- the machine not being ready for a new command due to another previously-issued command or a previously-detected hardware fault that prevents motion
- an illegal request to move a cartridge from an empty location or to a full location
- an illegal request to do an unsupported command or operation



- invalid syntax or parameters in a command
- various bus-level communication errors

In all of these cases, the command is rejected immediately and the autochanger is not moved.

#### **6.7.4 Move Errors**

If an error is detected during an autochanger motion, the state of the machine is recorded in internal memory and a retry procedure is called. Errors of this type may be either physical or logical, and may be recoverable or unrecoverable. Results of the error recovery are returned to the host when the command completes. If possible, the cartridge is returned to its original location before command completion, putting the autochanger back into its original state.

Logical errors refer to conditions in which source locations were found unexpectedly empty or destination locations were found unexpectedly full. These conditions indicate that a cartridge was moved without the knowledge of the autochanger, possibly during service. At this point, the host must become involved in locating the source of the error.

The host's actions can include issuing a Read Element Status command to find the difference between the host's location (element) list and that of the autochanger, followed by an Initialize Element Status command to find the actual locations of all disks. When the differences are determined, a final check of data on the disk should be done, with replacement to the appropriate location (element).

The picker "element status" always reflects the physical state of the picker. The autochanger will not give a status when the picker is found unexpectedly full or empty because this logical error is not allowed. At power-on, the picker is checked to see if it contains a cartridge. The mechanical design of the picker prevents a cartridge from being fully inserted into the picker without first going through an initial power-on cycle in the autochanger.

Physical errors refer to conditions in which something physically changes in the system that prevents normal operation of the motion. These can be either temporary or permanent. Error recovery attempts to recover from every physical error without host intervention. Any error that is detected through overforce, sense of touch, or by a sensor calls a procedure to attempt the recovery.

One exception to the no-host-intervention rule is in the drive/autochanger interaction. If the autochanger indicates that a cartridge has been inserted into the drive, but the drive does not read it, the host must become involved in identifying the source of the problem. Likewise, if the drive is commanded to eject a cartridge and does not do so, the drive is considered to be empty and the

host must identify either the final position of the cartridge or determine if the drive has failed.

### **6.7.5 Hardware Error Codes**

If an error is unrecoverable (i.e., something is broken or jammed to a point that manual intervention is required), the autochanger takes an additional step in an attempt to identify the Field Replaceable Unit (FRU) that is causing the failure.

A routine is called automatically that performs a process of elimination for various FRUs. This routine attempts to isolate the error to three (or less) FRUs. If no error can be found (or if recovery was made from the error), the unit returns a "no error" status. If an error is found, a hardware error code and a move error code is returned when the command completes. Up to three FRU numbers are returned. The FRUs, and a time stamp, are listed in decreasing order of probability.

### **6.7.6 Real Time Event Logging**

#### **Logs**

The optical disk library provides information logs about the autochanger's operation and error history. The logs can provide predictive information which could lead to early detection of autochanger problems.

All the logs are maintained within the non-volatile RAM and are accessible through the control panel and by the SCSI Log Sense command over the SCSI interface. The main functions provided with operational logs are described below.

#### **Error Log**

The autochanger maintains a history of past diagnostic test errors which have occurred within the autochanger, together with a time stamp of when they occurred. The error message maintained for each error indicates the failure and the possible FRUs which may have caused the failure.

#### **Move Success Log**

A cumulative number of move recoveries and a total move count are maintained. This gives service a view of the history of the autochanger soft error rate. The last ten hard errors are marked in this log by indicating how many good moves occurred since the last hard error.

#### **Force Log**

Each cartridge move is actually a sequence of many small moves, known as micro-moves. This log is a record of the maximum force measured during every micro-move situation.

### **Recovery Log**

This is a record of recoverable (soft) errors, and related information on error recovery methods used and their success or failure.

### **Drive Log**

This data indicates the number of times the autochanger uses each drive.

### **Run-Time Log**

An entry is put into this log each time an error occurs which requires any form of recovery. Both "on-the-fly" and extensive recovery methods are logged. The type of error, the method of recovery, and the number of moves to that point are recorded.

### **Odometer**

This value indicates the total number of moves executed since the non-volatile RAM was first initialized. Power-on hours are also logged.

## **6.8 The SCSI Interface**

As defined by ANSI (American National Standards Institute), SCSI allows up to eight devices on the bus in any combination of computers and peripherals. The devices can communicate with one another without control from a host computer.

Another powerful feature is the ability of SCSI to perform arbitration. SCSI allows the host to initiate transactions, then break communication with a device, do something else, and re-establish communication when the device is ready.

Finally, SCSI is capable of high data transfer rates. Synchronous data transfer rates may be as fast as 4 Mbytes/second, and asynchronous rates up to 1.5 Mbytes/second, limited only by the capabilities of the computer and peripheral.

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### **CAUTION**

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Do not switch off any peripheral on the SCSI bus without first checking that the bus is not active.

Switching off can cause data loss and/or indeterminate bus states.

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## 6.8.1 SCSI Command Set

The following SCSI-2 commands can be used with the optical disk library.

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**Note**

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Detailed descriptions of these commands and their functionality with optical products can be found in the following documents:

- Offline Diagnostics, located in Appendix A.
  - American National Standards Institute (ANSI) document titled, "Small Computer System Interface - 2 (SCSI-2)," revision 10H which is dated September, 1991. Copies of this publication can be obtained by writing to: Global Engineering Documents, 2805 McGaw, Irvine, CA 92714, or call: (800) 854-7179 or (714) 261-1455. Please refer to document X3.131-SCSI-2.
  - Multifunction Optical Drive and Library SCSI-2 Command Reference. This document can be obtained by ordering part number 5960-7606 from the Sales Response Center at Hewlett-Packard. For order information, refer to Appendix B.
  - HP Technical Guide Optical Drives and Libraries, obtained by ordering part number 5960-7605 from the Sales Response Center at Hewlett-Packard. For order information, refer to Appendix B.
- 

The following tables list the SCSI-2 commands numerically, by group.

**Table 6-5 Group 0 Commands (6-byte command)**

Code (Hex.)	Name	Description
00	Test Unit Ready	Provides a means to check if the logical unit is ready
01	Rezero Unit	Moves the optical head to its recalibration position
03	Request Sense	Requests the detailed error information
04	Format Unit	Initializes the optical disk (done only once for unformatted, write-once disks)
07	Reassign Blocks	Reassigns defective sectors

(continued on next page)

**Table 6–5 (Cont.) Group 0 Commands (6-byte command)**

Code (Hex.)	Name	Description
08	Read	Reads data from the specified logical block address
0A	Write	Writes data to the specified logical block address
0B	Seek	Moves the optical head to the physical track where the specified logical block exists
12	Inquiry	Reads the information related to the controller and the drive unit
15	Mode Select	Sets optical disk, drive unit, or controller unit parameters
16	Reserve	Gains the exclusive control of a specified logical unit
17	Release	Releases a specified logical unit from the reservation state
1A	Mode Sense	Reads optical disk, drive unit, or controller unit parameters
1B	Start/Stop Unit	Starts or stops rotating the optical disk, and/or ejects the optical disk from the drive unit
1C	Receive Diagnostic Results	Requests analysis data be sent to the initiator
1D	Send Diagnostic	Requests the disk controller to perform diagnostic tests
1E	Prevent/Allow Medium Removal	Prevents or allows removal of the optical disk in the logical unit

**Table 6–6 Group 1 and 2 Commands (10-byte command)**

Code (Hex.)	Name	Description
25	Read Capacity	Reads the capacity of the optical disk
28	Read	Reads data from the specified logical block address
2A	Write	Writes data to the specified logical block address

(continued on next page)

**Table 6–6 (Cont.) Group 1 and 2 Commands (10-byte command)**

<b>Code (Hex.)</b>	<b>Name</b>	<b>Description</b>
2B	Seek	Moves the optical head to the physical track where the specified logical block exists
2C	Erase	Executes erase operation from the specified logical block address on rewritable disks only
2E	Write and Verify	Writes data to the optical disk and then verifies the written data by checking the error correction code
2F	Verify	Verifies the data starting from the specified logical block address by checking the error correction code
34	Pre-Fetch	Reads the data from the specified logical block address into the drive's controller cache memory
35	Synchronize Cache	Initiates the writing of all cached write data to the optical disk
37	Read Defect Data	Reads the optical disk defect information
3B	Write Buffer	Writes data to the controller data buffer
3C	Read Buffer	Reads data from the controller data buffer
3E	Read Long	Reads data from the specified logical block address including ECC data
3F	Write Long	Writes data to the specified logical block address without using the ECC generation circuitry
4C	Log Select	Clears drive resident logs and odometers
4D	Log Sense	Reads drive resident logs and odometers
55	Mode Select	Sets optical disk, drive unit, or controller unit parameters
5A	Mode Sense	Reads optical disk, drive unit, or controller unit parameters

**Table 6–7 Group 5 Commands (12-byte command)**

<b>Code (Hex.)</b>	<b>Name</b>	<b>Description</b>
A8	Read	Reads data from the specified logical block address
AA	Write	Writes data to the specified logical block address
AC	Erase	Executes erase operation from the specified logical block address on rewritable disks only
AE	Write and Verify	Writes data to the optical disk and then verifies the written data by checking the error correction code
AF	Verify	Verifies the data starting from the specified logical block address by checking the error correction code
B7	Read Defect Data	Reads the optical disk defect information





# A

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## Offline Diagnostic Information

### A.1 System Error Report

Figure A-1 shows a typical VAX/VMS system error report. After analyzing the report for symptoms, proceed to Section A.2.

**Figure A-1 System Error Report**

```

V A X / V M S          SYSTEM ERROR REPORT          COMPILED  8-APR-1993 15:11:43
                                                           PAGE    1.

***** ENTRY          9. *****
ERROR SEQUENCE 6552.          LOGGED ON:          SID 0A000005
DATE/TIME 8-APR-1993 15:10:09.37          SYS_TYPE 04010102
SYSTEM UPTIME: 5 DAYS 21:14:31
SCS NODE: KAWA          VAX/VMS V5.4-2

DEVICE ERROR KA420 CPU FW REV# 6.
GENERIC DK SUB-SYSTEM, UNIT_KAWA$WDB300:

HW REVISION          00A50015          HW REVISION = ..#.
ERROR TYPE          05          EXTENDED SENSE DATA RECEIVED
SCSI ID          03          SCSI ID = 3.
SCSI LUN          00          SCSI LUN = 0.
SCSI SUBLUN          00          SCSI SUBLUN = 0.
PORT STATUS          00000054          %SYSTEM-F-CTRLERR, FATAL CONTROLLER
SCSI CMD          00000003          ERROR
                                0078          REQUEST SENSE
SCSI STATUS          00          GOOD

EXTENDED SENSE DATA
EXTENDED SENSE          000B0070 ← Extended Sense Data Sense Key 0Bh
                                0A000000 ← 1st Byte of Extended Sense
                                00000000
                                0000004E ← Byte 12
                                00A50000
                                1A000000 ← SCSI Command Packet
                                00000100
                                07030000
                                00

UCB$B_ERTCNT          03          ABORTED COMMAND ← Sense Key
SENSE CODE = 4E(X) ← Additional Sense
                                3. RETRIES REMAINING          Code (ASC) 4Eh =
                                3. RETRIES ALLOWABLE          Bus Protocol Error

ORB$L_OWNER          00000000          OWNER UIC [000,000]
UCB$L_CHAR          1CC54008          DIRECTORY STRUCTURED
                                FILE ORIENTED
                                SHARABLE
                                AVAILABLE
                                ERROR LOGGING
                                ALLOCATED
                                CAPABLE OF INPUT

```

## A.2 Autochanger Error Codes

This section contains the following autochanger error code tables:

- Request Sense Codes
- Request Sense Maps
- Move Error Codes
- Micro-Move Failure Type Codes

**Figure A-2 Jukebox Request Sense Data Parameter Block Format**

Byte	7	6	5	4	3	2	1	0
0	Valid (0)	Error Code (70h or 71h)						
1	Reserved (0)							
2	Reserved (0)				Sense Key *			
3-6	Reserved (0)							
7	Additional Sense Length *							
8-11	Reserved (0)							
12	Additional Sense Code							
13	Additional Sense Code Qualifier							
14	Reserved (0)							
15	SKSV	Sense Key Specific						
16-17	Sense Key Specific							

Error Code Either 70h (current error under VMS) or 71h (deferred error)

\* = See Table A-1

**Table A-1 Sense Key and Additional Sense Length Values**

<b>Sense Key (hex)</b>	<b>Description</b>	<b>Additional Sense Length</b>
00	No Sense—Normal conditions	10
01	Recovered Error—Usually everything is OK	70
02	Not Ready—Typically a disk isn't spun up or inserted	10
03	Medium Error—May or may not be a serious problem	
04	Hardware Error—Usually a serious problem	70
05	Illegal Request—Usually a software problem	10
06	Unit Attention—Power on, RESET, a disk inserted, etc.	10
07	Data Protect—Tried to write to a write-locked disk	
08	Blank Check—A blank sector was encountered on a READ or wasn't blank on a WRITE	
0B	Aborted Command	10

**Additional Sense Code**— The Additional Sense Code specifies detailed information related to the error reported in the Sense Key field.

**Additional Sense Code Qualifier**—The Additional Sense Code Qualifier specifies detailed information related to the Additional Sense Code.

**SKSV**—When set to 1, the Sense Key Specific bytes contains valid data. When set to 0, bytes 15, 16, and 17 are null.

**Sense Key Specific**— Valid only when the Sense Key field is set to Illegal Request (05H) and SKSV is 1.

**Additional Sense Bytes**—This field may contain information when the Additional Sense Length field contains a value greater than 10. See Figure A-3.

**Figure A-3 Jukebox Request Sense—Additional Sense Data**

Byte	7	6	5	4	3	2	1	0
18	Move Error Code *							
19	Hardware Error Code (See list of Hardware Errors in Service Manual)							
20	First FRU (See list of FRUs in Service Manual)							
21	Second FRU							
22	Third FRU							
23	MvCap	Last	Rsvd (0)	PosLost	Cartin	Reserved (0)		
24-25	Reserved (0)							
26	DinRty	DEjRty	PkrRec	CarAssy	Reserved (0)		BFHm	FHR
27	Retry Count							
28-29	Reserved (0)							
30	DinRty	DEjRty	PkrRec	CarAssy	Reserved (0)		BFHm	FHR
31	Recovery Count							
32-34	Reserved (0)							
35	Valid	ErrEn	Cartin	CartEI	UnexpMt	UnexpF	Cartinv	EIRty
36-37	Source Element Number							

\* = See Table A-2

### Jukebox Request Sense – Additional Sense Data (continued)

Byte	7	6	5	4	3	2	1	0
38	Valid	ErrEn	Cartin	CartEI	UnexpMt	UnexpF	Cartinv	EIRty
39–40	Destination Element Number							
41	Valid	ErrEn	Cartin	CartEI	UnexpMt	UnexpF	Cartinv	EIRty
42–43	Secondary Source Element Number							
44	Valid	ErrEn	Cartin	CartEI	UnexpMt	UnexpF	Cartinv	EIRty
45–46	Second Destination Element Number							
47–49	Reserved (0)							
50–54	Micro–Move ID History *							
55	Failed Micro–Move ID							
56	Micro–Move Error Code **							
57–60	Vertical Motor Commanded Position							
61–64	Vertical Motor Actual Position							
65–68	Horizontal Motor Commanded Position							
69–72	Horizontal Motor Actual Position							
73–77	Reserved (0)							

\* = See the Micro-Move ID Table

\*\* = See Table A–3

**Move Error Code**— The movement that was being performed when the error occurred. The values of the Move Error Codes are in Table A-2.

**Hardware Error Code** – Determined by fault isolation, this error code indicates the cause of the failure. Hardware error codes are listed in the “Troubleshooting and Diagnostics” chapter of the service manual.

**First FRU** –The most likely field replaceable unit (FRU) to be the cause of the failure. See the “Removal and Replacement” chapter of the service manual for a list of FRUs.

**Second FRU**— The second most likely field replaceable unit (FRU) to be the cause of the failure. See the “Removal and Replacement” chapter of the service manual for a list of FRUs.

**Third FRU**—The third most likely field replaceable unit (FRU) to be the cause of the failure. See the “Removal and Replacement” chapter of the service manual for a list of FRUs. **NOTE** The FRUs returned should be considered ++pointers++ to the best area within the unit to check for the fault. Simply changing the FRU listed may or may not fix the associated problem.

**MvCap**— A Move Capable bit of 1 indicates the autochanger is capable of performing move commands.

**LastSCSI** – A Last bit of 1 indicates the autochanger has successfully returned the cartridge to the state they were in before the failed command was executed.

**PostLost**— A Position Lost bit of 1 indicates the autochanger cannot calibrate the mechanism and has lost position of the picker.

**CartTrans**— A Cartridge in Transport bit of 1 indicates a cartridge is in the picker mechanism.

**DInRty**—A Drive Insert Retry bit of 1 indicates that more than one attempt was needed to insert the cartridge into the drive. (For byte 26, this attempt refers to Retry algorithm and for byte 30 it refers to Recovery algorithm).

**DEjRty**—A Drive Eject Retry bit of 1 indicates that more than one attempt was needed to eject the cartridge from the drive. (For byte 26, this attempt refers to Retry algorithm and for byte 30 it refers to Recovery algorithm).

**PkrRec**—A Picker Retracted bit of 1 indicates the picker fingers were fully retracted after a failure. (For byte 26, this attempt refers to Retry algorithm and for byte 30 it refers to Recovery algorithm).

**CarAssy**—A Carriage Locked bit of 1 indicates the picker fingers were fully retracted after a failure and the translate pin is engaged. (For byte 26, this attempt refers to Retry algorithm and for byte 30 it refers to Recovery algorithm).

**BFHm**—A Bad Find Home bit of 1 indicates the Find Home algorithm was started while the optical sensors were inoperable. (For byte 26, this attempt refers to Retry algorithm and for byte 30 it refers to Recovery algorithm).

**FHR**—A Find Home Recalibration bit of 1 Find Home algorithm was invoked to recalibrate the mechanism (For byte 26, this attempt refers to Retry algorithm and for byte 30 it refers to Recovery algorithm).

**Retry Count**— The total number of retry attempts that were performed.

**Recovery Count**— The total number of recovery attempts that were performed.

**Valid**— A “0” indicates that this and the next two bytes contain invalid data. Valid in bytes 41 and 44 are only set during the Exchange Medium Command.

**ErrEn**—An Error Encountered bit of 1 indicates an error occurred while the picker was enroute to this element.

**CartEl**—A Cartridge in Element bit of 1 indicates the cartridge associated with this move is in this element.

**UnexpMt**—An Element Unexpected Empty bit of 1 indicates this element was unexpectedly empty.

**UnexpFl**—An Element Unexpected Full bit of 1 indicates this element was unexpectedly full.

**CartInv**—A Cartridge Inverted bit of 1 indicates the cartridge is inverted from its state before the operation began.

**ElRty**—An Element Required Retry bit of 1 indicates an operation in or out of this element required one or more retries.

**Source Element Number**—The Element Number to which the Source Element Bit Map (byte 35) refers.

**Destination Element Number**—The Element Number to which the Destination Element Bit Map (byte 38) refers.

**Secondary Source Element Number**—The Element Number to which the Secondary Source Element Bit Map (byte 41) refers.

**Second Destination Element Number**— The Element Number to which the Second Destination Element Bit Map (byte 44) refers.

**Micro-Move ID History**—The last five autochanger Micro-Move IDs for the original movement command prior to the failure. Refer to the Micro-Move ID Table in this manual.

**Failed Micro-Move ID** —Actual micro-move that failed.



Micro-Move Error Code—The error code associated with the failed Micro-Move ID. See Table A-3.

Vertical Motor Commanded Position—The position to which the carriage motor was commanded.

Vertical Motor Actual Position—The actual position of the carriage motor.

Horizontal Motor Commanded Position—The position to which the picker motor was commanded.

Horizontal Motor Actual Position—The actual position of the picker motor.

**Table A-2 Autochanger Move Errors**

<b>Error Codes</b>	<b>Failure Description</b>
00	Failure occurred before any servo-controlled motions were attempted during Power on Selftest.
02	Failure while Picker is not moving.
04	Failure while moving the carriage/picker assembly away from drives.
06	Failure while moving the carriage/picker assembly toward drives.
08	Failure while flipping the picker.
0A	Failure while translating the picker assembly.
0E	Failure while moving the picker fingers back in preparation to translate.
10	Failure while moving the picker fingers to engage the cartridge from the source storage element.
12	Failure while moving the picker fingers back to remove the cartridge from the source storage element.
18	Failure while moving the picker fingers forwards to insert a cartridge in the destination storage element.
1A	Failure while moving the picker fingers back after inserting a cartridge in the destination storage slot.
20	Failure while moving the picker fingers forwards to engage the cartridge ejected from the drive (source).
22	Failure while moving the picker fingers back to remove the cartridge from the drive (source).
28	Failure while moving the picker fingers forwards to insert the cartridge into the drive (destination).

(continued on next page)

**Table A–2 (Cont.) Autochanger Move Errors**

<b>Error Codes</b>	<b>Failure Description</b>
2A	Failure while moving the picker fingers back after inserting a cartridge into the drive (destination).
30	Failure while moving the picker fingers forward to engage the cartridge in the mailslot (source).
32	Failure while moving the picker fingers back to remove the cartridge from the mailslot (source).
38	Failure while moving the picker fingers forward to insert the cartridge in the mailslot (destination).
3A	Failure while moving the picker fingers back after inserting the cartridge in the mailslot (destination).
40	Failure while rotating the mailslot actuator inward.
42	Failure to ensure that the mailslot rotated inward.
48	Failure while rotating the mailslot actuator outward.
4A	Failure to ensure that the mailslot rotated outward.
50	Failure while the finding the home position.
52	Failure while calibrating the carriage/picker assembly.
60	Initializing element status failed while testing an element with a cartridge in the picker assembly.
80	Failure to remove a cartridge from a source element.
84	Failure to leave a cartridge properly in a destination element.
88	An obstruction was encountered before the cartridge had been inserted the proper distance.
90	Source element unexpectedly empty.
94	Destination element unexpectedly full.
A0	Front mailslot sensor failed.
A2	Inside mailslot sensor failed.
A4	Drive light stuck on.
B0	Door interlock open.

**Table A-3 Autochanger Micro-Move Error Codes**

<b>Error Code (hex)</b>	<b>Description</b>
Micro-Move Errors are reported in byte 56 of the additional sense bytes (Figure A-3).	
0	No error.
1	Carriage motor drive voltage exceeded limit set by firmware.
2	Carriage motor overcurrent detected by hardware.
3	Carriage motor force exceeded limit set by firmware.
4	Picker motor drive voltage exceeded limit set by firmware.
5	Picker motor overcurrent detected by hardware.
6	Picker motor force exceeded limit set by firmware.
7	Low power supply during motion.
8	High power supply during motion.
9	Move stopped because cartridge-in-path beam blocked.
A	Cartridge not detected by cartridge-in-path beam.
B	Carriage motor not tracking properly.
C	Picker motor not tracking properly.
D	Carriage motor measured voltage less than expected.
E	Picker motor measured voltage less than expected.
10	Find origin failed.
11	Calibrate failed.
12	Diagnose FRU failed.
13	Initial recovery failed.
14	Find home failed.
15	Picker initialization failed.
16	Cartridge-in-path beams are blocked.
20	Failed to find hard stop at end of flip.
22	Failed to see sensor close at the end of translate.
23	Failed to move to the vertical position needed to engage the translate pin.
24	Failed to see sensor close at the start of translate.

(continued on next page)

**Table A-3 (Cont.) Autochanger Micro-Move Error Codes**

<b>Error Code (hex)</b>	<b>Description</b>
25	Failed to see height sensor re-open after closing at the start of a translate.
28	The translate distance was too long.
29	The translate distance was too short.
31	Failed while checking for cartridge in a drive.
32	Failed to find a hard stop returning cartridge to storage after testing for presence of cartridge.
33	Failed while checking for cartridge in a storage slot.
34	Failed while checking for cartridge in the Picker.
35	Failed while checking for cartridge in the mailslot.
36	Could not free fingers after testing for a cartridge in a drive.
38	Failed to verify that cartridge exists after insert.
40	Failed finding the back of storage slot during retraction.
41	Failed to verify that a disk is in the storage slot on get using cartridge-in-path beams.
42	Not able to measure the depth of the storage slot.
43	Failed to free fingers from the storage slot.
48	Could not find the back of the storage slot after insert.
49	Failed to verify that a cartridge exists in the storage slot after insert.
4A	Could not free fingers from storage slot after insert.
50	Could not find the back of the mailslot after get.
51	Failed to verify that a disk is in the mailslot on get using cartridge-in-path beams.
52	Not able to measure the depth of the mailslot.
58	Could not find the back of the mailslot after insert.
59	Failed to verify that a cartridge exists in the mailslot after insert.
60	Failed to rotate the mailslot in.
61	Failed to rotate the mailslot out.
70	Exhausted retries while attempting to get the drive to eject the cartridge.

(continued on next page)

**Table A-3 (Cont.) Autochanger Micro-Move Error Codes**

<b>Error Code (hex)</b>	<b>Description</b>
71	Could not verify that the drive ejected the cartridge.
72	Could not free fingers from the drive.
73	No cartridge in drive.
74	No load complete.
75	Drive error signal.
76	Unexpected cartridge in the drive.
77	Unexpected load complete.
78	Exhausted retries attempting to get drive to accept the cartridge.
79	Could not verify that the drive accepted the cartridge.
7E	Inline recovery attempts exhausted.
<b>Errors above are counted in the runtime log as in-line, errors below as retries.</b>	
90	Drive access was disallowed because drive busy signal was active.
91	Drive light stuck off.
94	Outside mailslot sensor failed.
95	Inside mailslot sensor failed.
96	Mailslot rotation failure; possibly caused by operator.
FA	Test drive insert retry.
FB	Timed out waiting for drive to eject when testing for the presence of a cartridge; retry being attempted.
FC	Retry being attempted on drive insert.
FD	Retry being attempted on drive eject.
FE	Mechanism error.

### **A.3 Drive SCSI-2 Reference**

This section contains the following information:

- Request Sense Command sense key values
- Request Sense Command additional sense code values
- HP-Specific Error Codes

**Figure A-4 Drive Request Sense Data Parameter Format**

Byte	7	6	5	4	3	2	1	0
0	AV	Error Code (70H or 71H)						
1	Reserved (0)							
2	Reserved (0)	ILI	Rsvd (0)	Sense Key*				
3	Information (MSByte)							
4	Information							
5	Information							
6	Information (LSByte)							
7	Additional Sense Length (0AH)							
8	Command Specific Information (MSByte) (reassign blocks only)							
9	Command Specific Information (reassign blocks only)							
10	Command Specific Information (reassign blocks only)							
11	Command Specific Information (LSByte) (reassign blocks only)							
12	Additional Sense Code**							
13	Additional Sense Code Qualifier**							
14	Reserved (0)							
15	SKSV	Sense Key Specific Information (if Sense Key = 1,3,4,5)						
16	Sense Key Specific Information							
17	Sense Key Specific Information							
18	HP-Specific Error Code***							
19	HP-Specific Error Code***							
20	Reserved (0)							
21	HP-Specific DSP Error Information (MSByte)							
22	HP-Specific DSP Error Information (LSByte)							
23	HP-Specific DSP Status Byte							

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These asterisks are keyed to Figure A-4:

- \* = See Table A-1
- \*\* = See Table A-4
- \*\*\* = See Table A-5

**AV-** A Valid bit of 1 indicates the information field contains valid information. A Valid bit of 0 indicates that the information field does not contain valid data.

**ILI-** An Incorrect Length Indicator bit of 1 usually indicates that the requested logical block length did not match the logical block length of the data on the medium.

**Information-**

1. The logical block address associated with the sense key.
2. The difference (residue) of the requested length minus the actual length in either bytes or blocks, as determined by the command, when the ILI bit is set.

**Command Specific Information-** The logical block address of the first defect descriptor not reassigned is returned in this field.

**SKSV-** A Sense Key Specific Valid bit of 1 indicates that the Sense Key Specific Information is valid. A SKSV bit of 0 indicates that there is no sense key specific information.

**Sense Key Specific Information-** If the Sense Key equals 1, 3, or 4, then byte 16 (MSbyte) and byte 17 (LSbyte) indicate Actual Retry Count.

If the Sense Key Specific Information (Byte 2, Bits 0-3) is set to 5-Illegal Request and the SKSV bit is set to 1, the sense key specific field is defined as Field Pointers, byte 16 (MSbyte) and byte 17 (LSbyte).

The Field Pointer field indicates which illegal parameters in command descriptor blocks or data parameters are in error.

- A data bit of 1 in byte 6 indicates bad command.
- A data bit of 0 indicates bad data.

**Table A-4 Drive Request Sense - Additional Sense Code Values**

<b>Sense Code and Qualifier (hex)</b>	<b>Sense Key</b>	<b>Description (Bytes 12 and 13)</b>
00 00	0H - NS	No Additional Sense Information
02 00	4H - HE	No ESDI Command Complete
04 01	2H - NR	LUN in Process of Becoming Ready
04 02	2H - NR	LUN Not Ready, Initializing Command Required
04 03	2H - NR	LUN Not Ready, Manual Intervention Needed
04 04	2H - NR	LUN Not Ready, Format in Progress
06 00	4H - HE	No Reference Position Found
09 01	4H - HE	Tracking Servo Failure
09 02	4H - HE	Focus Servo Failure
09 03	4H - HE	Spindle Servo Failure
0C 01	1H - RE	Write Error Recovered with Auto Reallocation
0C 02	3H - ME	Write Error - Auto Reallocation Failed
10 00	4H - HE	ID CRC or ECC Error
11 00	3H - ME	Unrecovered Read Error
11 02	3H - ME	Error Too Long to Correct
11 07	3H - ME	Data Resynchronization Error
11 0B	3H - ME	Uncorrected Read Error - Recommend reassignment
11 0C	3H - ME	Uncorrected Read Error - Recommend rewrite
11 80	3H - ME	Unrecovered error, sparing failed
12 00	3H - ME	Address Mark Not Found for ID Field
13 00	3H - ME	Address Mark Not Found for Data Field
15 01	4H - ME	Mechanical Positioning Error
17 01	1H - RE	Recovered Data With Retries
17 05	1H - RE	Recovered Data Using Previous Sector ID
17 80	1H - RE	Recovered Data With Retries, Data Auto Reallocated
17 81	1H - RE	Recovered data - Auto Reallocate Failed
18 00	1H - RE	Recovered Read Data With ECC Procedure

(continued on next page)



**Table A-4 (Cont.) Drive Request Sense - Additional Sense Code Values**

<b>Sense Code and Qualifier (hex)</b>	<b>Sense Key</b>	<b>Description (Bytes 12 and 13)</b>
18 01	1H - RE	Recovered Data With ECC/Retries
18 02	1H - RE	Recovered Data With ECC/Retries, Data Auto Reallocated
19 01	3H - ME	Defect List Not Available
19 02	3H - ME	Defect List Error in Primary List
19 03	3H - ME	Defect List Error in Grown List
1A 00	5H - IR	Parameter List Length Error
1C 01	3H - ME	Primary Defect Lists Not Found
1C 02	3H - ME	Grown Defect Lists Not Found
1D 00	3H - ME	Miscompare During Verify Operation
20 00	5H - IR	Invalid Command Operation Code
21 00	5H - IR	Illegal Logical Block Address
22 00	5H - IR	Illegal Function
24 00	5H - IR	Invalid Field In CDB
25 00	5H - IR	Invalid LUN
26 00	5H - IR	Invalid Field In Parameter List
27 00	7H - DP	Write Protected
28 00	6H - UA	Medium Changed
29 00	6H - UA	Power-On, Reset or Bus Device Reset Occurred
29 80	4H - HE	Power-on, Reset or Bus Device Reset Occurred and Selftest Failed
2A 01	6H - UA	Mode Parameters Changed
2F 00	BH - AC	Commands Cleared by Initiator
30 01	3H - ME	Cannot Read Medium - Unknown Format
30 02	3H - ME	Cannot Read Medium - Incompatible Format
31 00	3H - ME	Medium Format Corrupted
32 00	3H - ME	No Defect Spare Location Available
32 01	3H - ME	Defect List Update Error

(continued on next page)

**Table A-4 (Cont.) Drive Request Sense - Additional Sense Code Values**

<b>Sense Code and Qualifier (hex)</b>	<b>Sense Key</b>	<b>Description (Bytes 12 and 13)</b>
3A 00	2H - NR	Medium Not Present
3D 00	5H - IR	Invalid Bits in Identify Message
3F 01	6H - UA	Microcode Has Been Changed
3F 03	6H - UA	Inquiry Data Has Changed
44 00	4H - HE	Internal target failure
40 80	4H - HE	Diagnostic Failure in NVRAM Odometers
40 81	4H - HE	Diagnostic Failure in NVRAM Configurations
40 82	4H - HE	Diagnostic Failure in NVRAM Logs
40 83	4H - HE	DSP Poweron Failure
40 84	4H - HE	DM Exception (unexpected flag)
43 00	BH - AC	Message Error
47 00	BH - AC	SCSI Parity Error
48 00	BH - AC	Initiator Detected Error
4E 00	BH - AC	Overlapped Commands Attempted
53 00	4H - HE	Media Load/Unload Failed
53 02	5H - IR	Medium Removal Prevented
55 00	2H - NR	System Resource Failure (xaction queue full)
92 00	8H - BC	Overwrite Attempted
93 00	8H - BC	Empty Sector Detected
94 00	8H - BC	Written Sector Detected
95 00	2H NR	Power Interruption Pending

**Table A-5 HP-Specific Drive Error Codes**

<b>Error Code (hex)</b>	<b>Message</b>
0201	No seek complete
0202	No reference position found
0203	Tracking servo failed
0204	Focus servo failed
0205	Spindle servo failed
0206	Mechanical position error
0207	Load unload failed
0208	DSP download failed
0209	DSP import x failed
020A	DSP import y failed
020B	DSP import p failed
020C	DSP export x failed
020D	DSP export y failed
020E	DSP export p failed
020F	DSP upload log failed
0210	DSP log checksum failed
0211	DSP passthru failed
0212	Fault spinup failed
0213	Recalibrate optical disk gain failed
0214	DSP log command error
0215	DSP log unsupported
0216	DSP log status error
0220	Active sector SPDET error
0221	Active sector empty sector
0222	Data DMA error
0223	PECC DMA error
0224	EDAC shift register error

(continued on next page)

**Table A-5 (Cont.) HP-Specific Drive Error Codes**

<b>Error Code (hex)</b>	<b>Message</b>
0225	ID CRC OR ECC error
0226	Data resync error
0227	Address mark error
0228	Sync mark error
0229	Incompatible format
022A	Active sector ENDEC unexpected
022B	Active sector higain with syncdet error
022C	Active sector syncmark dubbed error
022D	Active sector underflow/overflow error
022E	Active sector not empty
022F	Active sector no DSP status
0230	ENDEC locked on sector
0231	ENDEC locked prearmed
0232	ENDEC locked unexpected
0240	SEQ no transfer started
0241	SEQ unexpected EOHG
0242	SEQ unexpected status
0250	Media recognition failed
0251	Preamed Watchdog timeout
0260	DM Task bad event
0261	DM mailbox bad event
0262	Next CD bad state
0263	Next operation bad state
0264	DM retry sector operations bad state
0265	Retry drive state bad state
0266	Retry sector operations bad state
0267	DM retry operations, bad operation type

(continued on next page)

**Table A-5 (Cont.) HP-Specific Drive Error Codes**

<b>Error Code (hex)</b>	<b>Message</b>
02FF	DM abort transaction
2001	DSP recovery
2002	DSP error
2003	DSP fault
2004	DSP warning
2011	Active sector DSP recovery
2012	Active sector DSP error
2013	Active sector DSP fault
2014	Active sector DSP warning
2021	DSP unsolicited recovery
2022	DSP unsolicited error
2023	DSP unsolicited fault
2024	DSP unsolicited warning
202A	DSP unresponsive
202B	DSP over responsive
202C	DSP poweron failure
3001	SCSI controller kill error
3002	SCSI controller message error
3003	SCSI controller command error
3004	SCSI controller RAM error
3005	SCSI controller register error
3006	SCSI controller FIFO error
3007	SCSI controller target sequence error
3008	SCSI controller command sequence error
3009	SCSI controller STS sequence error
3010	Reselection timeout
4101	Error too long to correct

(continued on next page)

**Table A-5 (Cont.) HP-Specific Drive Error Codes**

<b>Error Code (hex)</b>	<b>Message</b>
4102	Data CRC failure
4103	ECC errors in interleave threshold exceeded
4401	DDS sector not found
4402	DDS reserved field not zero
4403	PDL reserved field not zero
4404	SDL reserved field not zero
4405	DDS ID field invalid
4406	PDL indicator field invalid
4407	Number of user groups (G) field invalid
4408	Number of user blocks per group (N) field invalid
4409	Number of spare blocks per group (M) field invalid
440A	User + spare blocks too large for media
440B	PDL sector not found
440C	SDL sector not found
440D	PDL length field invalid
440E	SDL number of sublists field not equal to one
440F	SDL list length field invalid
4410	PDL list incomplete
4411	PDL list not sorted
4412	PDL entry invalid
4413	SDL list incomplete
4414	SDL list not sorted
4415	SDL defect entry invalid
4416	SDL replacement entry invalid
4417	SDL defect entry in a spare group
4418	SDL replacement entry in a user group
4419	Too many defects (PDL + DSL)

(continued on next page)

**Table A-5 (Cont.) HP-Specific Drive Error Codes**

<b>Error Code (hex)</b>	<b>Message</b>
441A	DMA length too short for PDL to exist
441B	DMA length too short for SDL to exist
441C	No spare remaining
441D	Number of SDLs greater than total spares allocated
441E	DDS ID invalid for CCW media
441F	CCW media rejected
4420	Certification, erase pass failure
4421	Certification, write pass failure
4422	Certification, verify pass failure
4423	Certification, no defects remain
4424	Certification aborted
4425	No SD list for certification erase
4426	No maximum SD list for certification erase
4427	No SD list for certification write
4428	No maximum SD list for certification write
4429	No SD list for certification verify
442A	No maximum SD list for certification verify
442B	No write image memory available for certification
442C	No write buffer memory available for certification
442D	No SD list for reassign blocks read
442E	No SD list for reassign blocks write
442F	No SD list for reassign blocks read long
4430	No SD list for reassign blocks write long
4431	Reassign blocks, unexpected CD before read
4432	Reassign blocks, unexpected CD before write
4433	Reassign blocks, unexpected CD before read long
4434	Reassign Blocks, unexpected CD before write long

(continued on next page)

**Table A-5 (Cont.) HP-Specific Drive Error Codes**

<b>Error Code (hex)</b>	<b>Message</b>
4435	Reassign blocks, can't move data on CCW
4436	No defect maps found
4437	PDL duplicate entry found
4438	SDL duplicate entry found
4439	SFP not found
443A	SFP format field invalid
443B	SFP modulation field invalid
443C	SFP angular velocity field invalid
443D	SFP ECC code field invalid
443E	SFP sector size differs from detected
443F	SFP sectors in track 0 invalid
4440	SFP medium type invalid
4441	SFP largest track less than or equal to zero, invalid
4442	SFP download P-block failed
4443	DMA write failed all attempts
4444	EWR calibration error, no memory
4445	EWR calibration error, retries failed
4446	Spare retries were exhausted
4447	No memory for next spare table
4448	No working memory for read maps
4449	Retry error after DM error
444A	Sector was spared successfully
444B	No SD list for Reassign Blocks erase
444C	Reassign Blocks, unexpected CD before erase
444D	Format, number of user groups
444E	Format, number of user sectors per group
444F	Format, number of spare sectors per group

(continued on next page)



**Table A–5 (Cont.) HP-Specific Drive Error Codes**

<b>Error Code (hex)</b>	<b>Message</b>
4450	Sparing, empty sector following spare attempt
4451	Sparing, overwritten sector following spare attempt
4452	DMA 1 write failed
4453	DMA 2 write failed
4454	DMA 3 write failed

Be aware that error codes printed in **boldface type** are unique to a 1.3-Gbyte, Multifunction Drive.

<b>4455</b>	<b>SFP at outer diameter is invalid</b>
<b>4456</b>	<b>SFP at inner diameter is invalid</b>
<b>4457</b>	<b>SFP track pitch is invalid</b>
<b>4458</b>	<b>SFP number of bands is invalid</b>
<b>4459</b>	<b>SFP banding constant is invalid</b>
<b>445A</b>	<b>SFP number revolutions per band is invalid</b>
<b>445B</b>	<b>SFP media type differs</b>
<b>445C</b>	<b>SDL ID is invalid</b>
<b>445D</b>	<b>SDL 2X group kind invalid</b>
<b>445E</b>	<b>Format, no replacement CD available</b>
<b>445F</b>	<b>Too many PDL entries per band</b>
<b>4460</b>	<b>Format, initial erase maps failed</b>
<b>4461</b>	<b>DMA erase during write failed</b>
<b>4462</b>	<b>Blank check during format/certification failed</b>
<b>4463</b>	<b>No SD list for certification blank check</b>
<b>4464</b>	<b>No maximum SD list for certification blank check</b>
8201	Previous sector ID
8401	Recovered data spare failed

(continued on next page)

**Table A-5 (Cont.) HP-Specific Drive Error Codes**

<b>Error Code (hex)</b>	<b>Message</b>
C000	Invalid diagnostic test
C001	Register error
C002	RAM test error
C003	Checksum error
C004	CPU test error
C005	Forced test error
C006	NVRAM test error
C007	Microprocessor test error
C008	Microprocessor ROM test error
C009	Microprocessor RAM test error
C00A	EDAC test error
C00B	SEQ test error
C00C	ENDEC test error
C00D	Active sector test error
C00E	HMAC test error
C00F	Buffer RAM test error
C010	Data loopback error
C020	Connector loopback DBO IO error
C021	Connector loopback DB1 CD error
C022	Connector loopback DB2 MSG error
C023	Connector loopback DB3 REQ error
C024	Connector loopback DB4 ACK error
C025	Connector loopback DB5 ATN error
C026	Connector loopback DB6 SEL error
C027	Connector loopback DB7 BSY error
C028	Connector loopback DBP RST error

## **A.4 Offline Diagnostics**

A diagnostic utility called DOSDASS2 is available from Hewlett-Packard for accessing the optical disk library through the SCSI bus.

DOSDASS2 fully exercises either standalone multifunction optical drives or autochangers that contain multifunction optical drives. Information for getting and using DOSDASS2 is found in Appendix B.



# B

---

## Basic Supplies and Reorderable Parts

### B.1 Basic Supplies and Reorderable Parts

While no special tools are required to service the optical library, there are some commonly used items that may be stocked and available as an area resource.

Item	HP Part Number	Digital Part Number
Rewritable Optical Disk Cartridges (512 bytes/sector) Formatted capacity is 594 Mbytes per disk†		RWX1K-01 (30-38754-01)
Rewritable Optical Disk Cartridges (512 bytes/sector) Formatted capacity is 1.2 Gbytes per disk†		RWX5K-01 (30-38754-02)
Quantity 5 of RWX1K-01 Cartridges		DL-RWX1K-AA
Write-Once Optical Disk Cartridges (512 bytes/sector) Formatted capacity is 594 Mbytes per disk†		RWX1K-02 (30-40952-01)
Write-Once Optical Disk Cartridges (512 bytes/sector) Formatted capacity is 1.2 Gbytes per disk†		RWX5K-02 (30-40952-02)
Quantity 5 of RWX1K-02 Cartridges		DL-RWX1K-BA
0.9m (3 ft) SCSI jumper cable; Champ to Champ connectors		BC09K-03
1.8m (6 ft) SCSI interface cable		BC06P-06 (17-02659-02)
2.7m (9 ft) SCSI interface cable (External UPS); Champ to Honda connectors	C1708-60080	BC09D-09 (Storage Server)
Power cord		RW1KA-AA
Single-ended SCSI terminator	K2291	H8574-A

---

†To reorder media, call 1-800-DIGITAL or 1-800-344-4825

Item	HP Part Number	Digital Part Number
Differential SCSI terminator‡	A1658-62024	
115 V replacement fuse 3A 250 V‡	2110-0003	
230 V replacement fuse 3A 250 V‡	2110-0780	
Eject tool‡	C1708-88803	
Optical disk cleaning kit‡	C1700-88800	
Optical disk cleaner accessory kit (extra swabs and alcohol)‡	C1700-88801	
<i>Optical Disk Library System Technical Reference Manual</i>	5959-3559 (GSD)	
<i>Technical Guide Optical Drives and Libraries</i>	5960-7605	
<i>Optical Drive and Library SCSI-2 Command Reference</i>	5960-7606	
<i>Offline Diagnostics for HP Optical Products ‡</i>	5960-7626	

‡These parts can be ordered directly from the Hewlett-Packard SMO facility in California. Call 1-800-227-8164 between the hours of 6 A.M. and 5 P.M. Pacific Standard Time.

The Instruction Manual for the Offline PC based diagnostics, DOSDASS2, can also be ordered from the Hewlett-Packard SMO facility in California. The title of this manual is *Offline Diagnostics for Hewlett-Packard Optical Products* and the part number is 5960-7626. Extra copies may be available from Digital's Storage External Products Continuation Engineering Group in Shrewsbury (SHR), MA.

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**NOTE**

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To run the DOSDASS2 diagnostics, you must have an IBM AT-compatible computer, an adapter interface board (152x/154x), a SCSI cable, and the *Offline Diagnostics for Hewlett-Packard Optical Products* manual.

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All other manuals and the DOSDASS2 diagnostic software are available from the Hewlett-Packard Support Center in Greeley, Colorado. Call the Hewlett-Packard Support Hotline, (303) 350-4646, to order. Diagnostics and SCSI-2 Command Reference manuals are also available from internal CSC or from the Storage External Products, Continuation Engineering Group in Shrewsbury (SHR), MA.





# C

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## Capacity Upgrade Installation Instructions

This appendix includes instructions for installing the RW516-UA/RW536-UA capacity upgrade kits in the RW514 and RW534 optical disk libraries.

### C.1 RW516/RW536-UA Upgrade Kit Parts

- 7 cartridge magazines (P/N C1700-60026)
- 1 product serial number label
- 1 service information label
- 1 nameplate
- 1 controller PCA

### C.2 Tools Needed

- T-10, T-15, T-20, and T-25 Torx® drivers
- 5/32 ball tip hex wrench, at least 4 inches long
- needle-nose pliers
- service key for rear door

## C.3 Removing Power from the Optical Disk Library

---

### CAUTION

---

Do not press the optical disk library system operation switch or unplug the AC power cord until you are sure that the SCSI bus is inactive.

Either pressing the operation switch or unplugging the power cord when the SCSI bus is active can cause data loss and/or indeterminate bus states. (Check the host system reference manuals for information on checking the status of the SCSI bus.)

Opening the rear cabinet door automatically removes power to the optical disk library motors. When the rear cabinet door is open, disks that are already in a drive can be read; however, if the host issues an autochanger command to access a disk not currently in the drive, an error condition, or host "hang" results.

---

### C.3.1 Opening the Rear Door

---

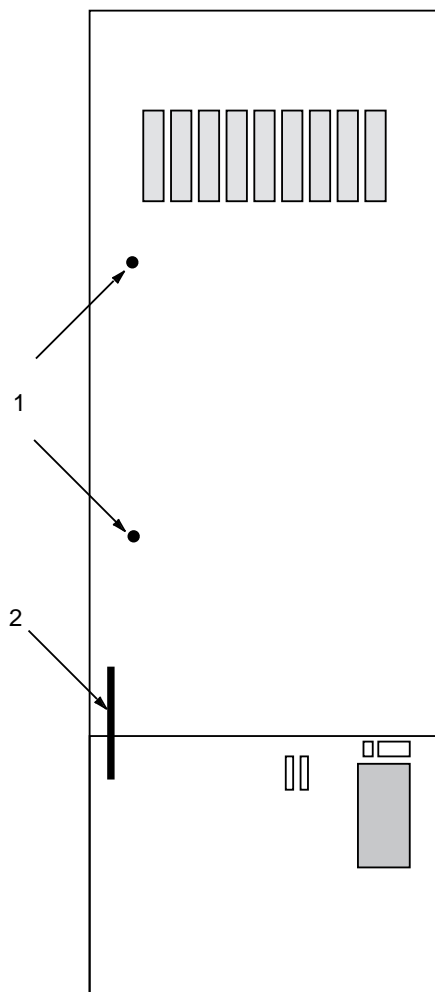
#### Note

---

The rear door may be secured with a lock added by the customer (see locking bracket location on Figure C-1). You may have to contact the system administrator to remove the lock.

---

**Figure C-1 Rear Panel Keyholes and Locking Bracket**



1. SEE CAUTION NOTE ON PREVIOUS PAGE.
2. Remove power from the autochanger by switching off the operation switch and then unplugging the optical disk library from line power.
3. Request that the customer remove the lock on the rear door (if necessary). See Figure C-1 for the location of the lock bracket.

4. Open the rear door using an access key. Each of the two latches has to be turned approximately 1/2 turn counterclockwise (Figure C-1).

---

**CAUTION**

---

When power is removed, the carriage/picker drifts down toward the bottom of the rails. As it drifts down, the picker fingers extend and finally catch on either the edge of a cartridge or the edge of a storage slot.

When the picker fingers are supported this way, it is possible to damage them if the carriage is struck during service.

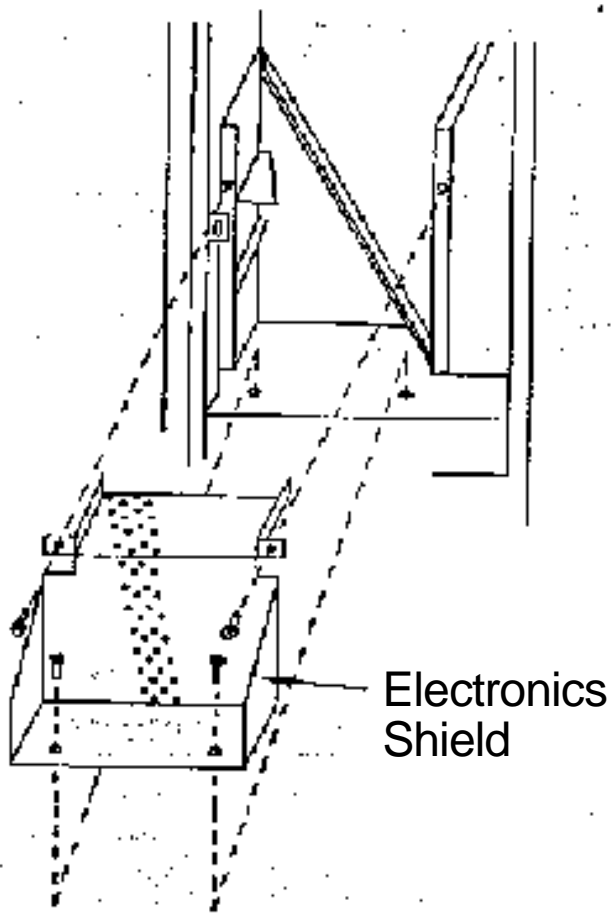
You can allow the carriage/picker assembly to slide all the way to the bottom of the rails (and out of your way) by pulling the picker leadscrew back and then moving the carriage down. The picker flips once as you move it down, but this is normal.

---

### **C.3.2 Removing the Lower Rear Panel**

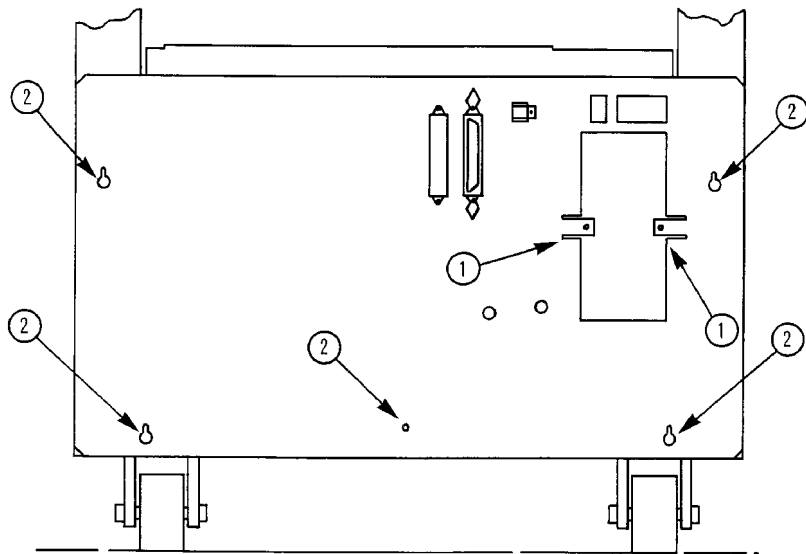
1. Remove power from the optical disk library by switching off the operation switch and then unplugging the optical disk library from line power.
2. Remove the external SCSI cable(s) and the external UPS cable, if present.
3. Remove the electronics shield.
  - a. Loosen the two screws in the keyhole openings on the electronics shield (Figure C-2).
  - b. Remove the remaining two screws.
  - c. Lift off the electronics shield.
4. Remove the SCSI ribbon cable from the top connector on the controller board.
5. Remove the red and black power cable from the SCSI repeater PCA and the cable clamp.
6. Remove the internal UPS cable from the interconnect board at the front of the autochanger. Unlatch the three cable clamps that route the cable to the lower rear panel, and remove the UPS cable from the clamps.

Figure C-2 Electronics Shield



7. Remove the two screws that hold the lower rear panel to the power supply (Figure C-3, 1).
8. Loosen the five screws in the keyholes around the perimeter of the lower rear panel (Figure C-3, 2).
9. Lift the panel up and away.

**Figure C-3 Lower Rear Panel**



## **C.4 Removing the Controller PCA**

1. Remove all cables connected to the autochanger controller PCA.
2. Remove the screw holding the metal PCA mounting plate to the frame (Figure C-4). Slide the PCA away from the frame.
3. Unpack the upgrade autochanger controller PCA.
4. Unpack the 4 upgrade ROMs.
5. Use the old autochanger controller PCA as a guide to placing the upgrade firmware into the correct locations on the upgrade PCA. The location of the ROM sockets is shown in Figure C-5.
6. Slide the new autochanger controller PCA into place.
7. Attach the PCA mounting plate to the frame with the single T-25 screw previously removed.

8. Replace the connectors to the PCA as they were on the original controller PCA.

**Figure C-4 Autochanger Controller PCA Mounting**

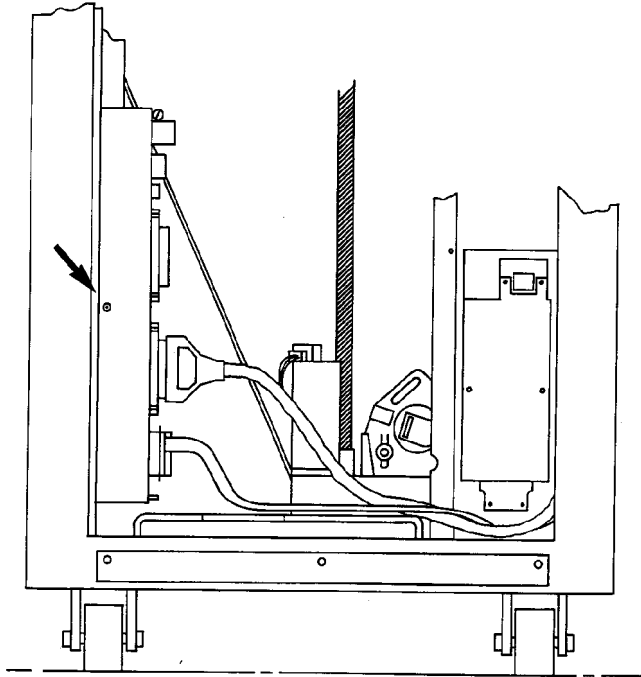
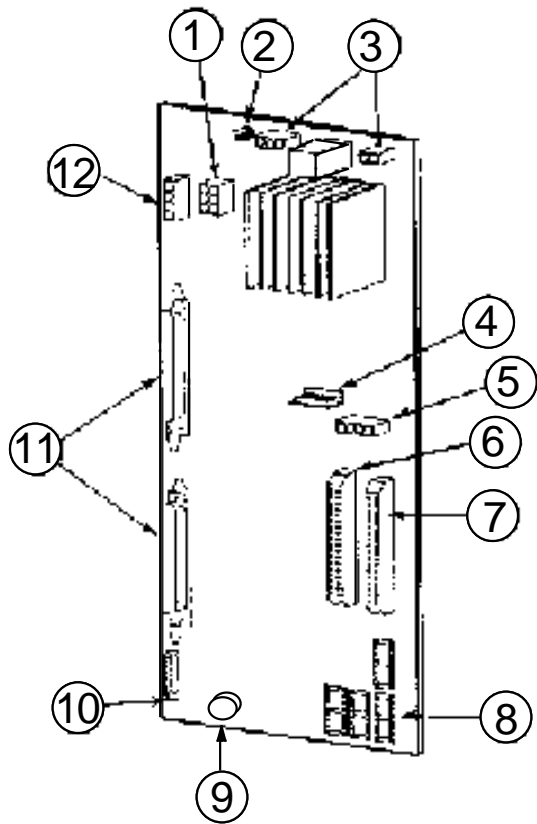


Figure C-5 Autochanger PCA Connectors/Components





<b>No.</b>	<b>Connector/Component</b>	<b>No.</b>	<b>Connector/Component</b>
1	Power in	7	To interconnect PCA
2	To door interlock	8	ROM sockets
3	Motor control (power)	9	Lithium battery
4	Motor control (functions)	10	RS-232 to control panel
5	Power in	11	Single-ended SCSI connector
6	To sensor receiver PCA	12	Cooling fan power

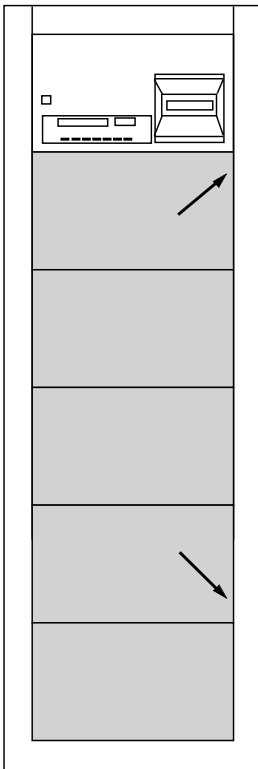
## C.5 Installing the Additional Magazines

### C.5.1 Opening the Front Door

Loosen the front panel latches by turning them counterclockwise with a long, 5/32-inch hex wrench. It may take several turns to release the spring-tensioned latch.

- The top latch is behind the TOP hole (Figure C-6).
- The bottom latch is behind the BOTTOM hole of the second panel up from the bottom (Figure C-6).

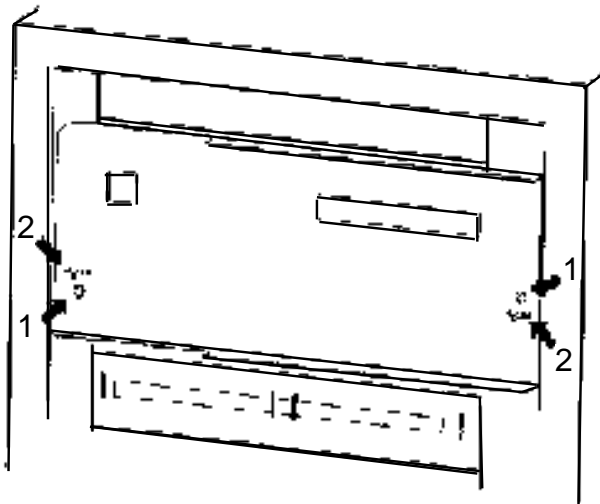
Figure C-6 Front Door Latch Holes



## C.5.2 Mounting the Additional Magazines

1. Remove the T-25 screws that mount the mailslot cover panel (Figure C-7, 1).

Figure C-7 Mailslot Cover Panel



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**Note**

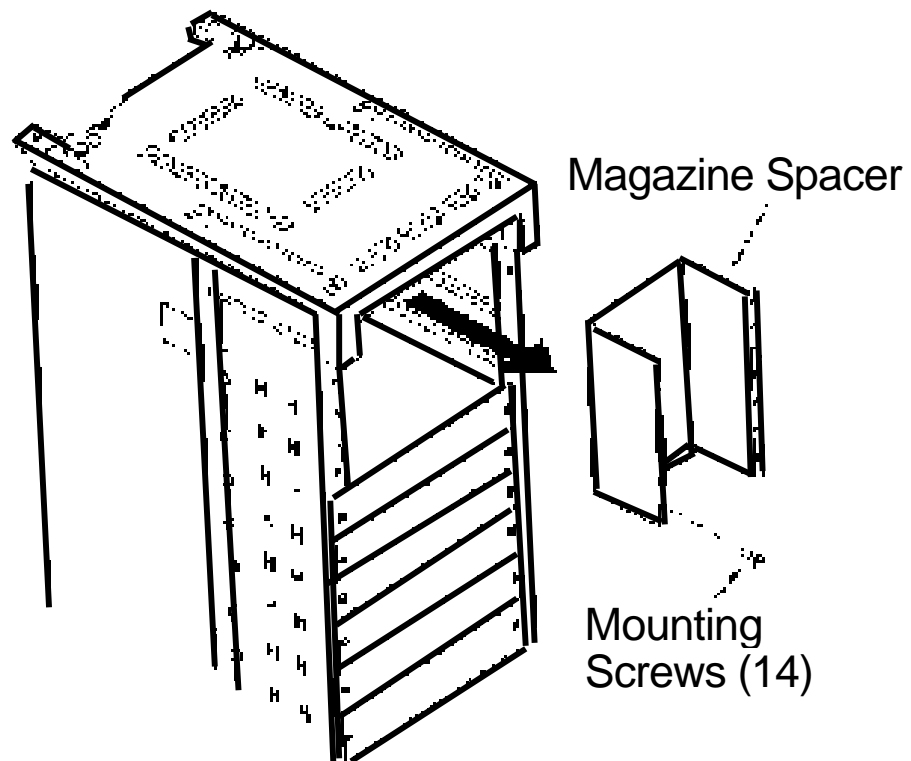
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Figure C-7, 2 also shows the guide pins used to position the cover during re-assembly.

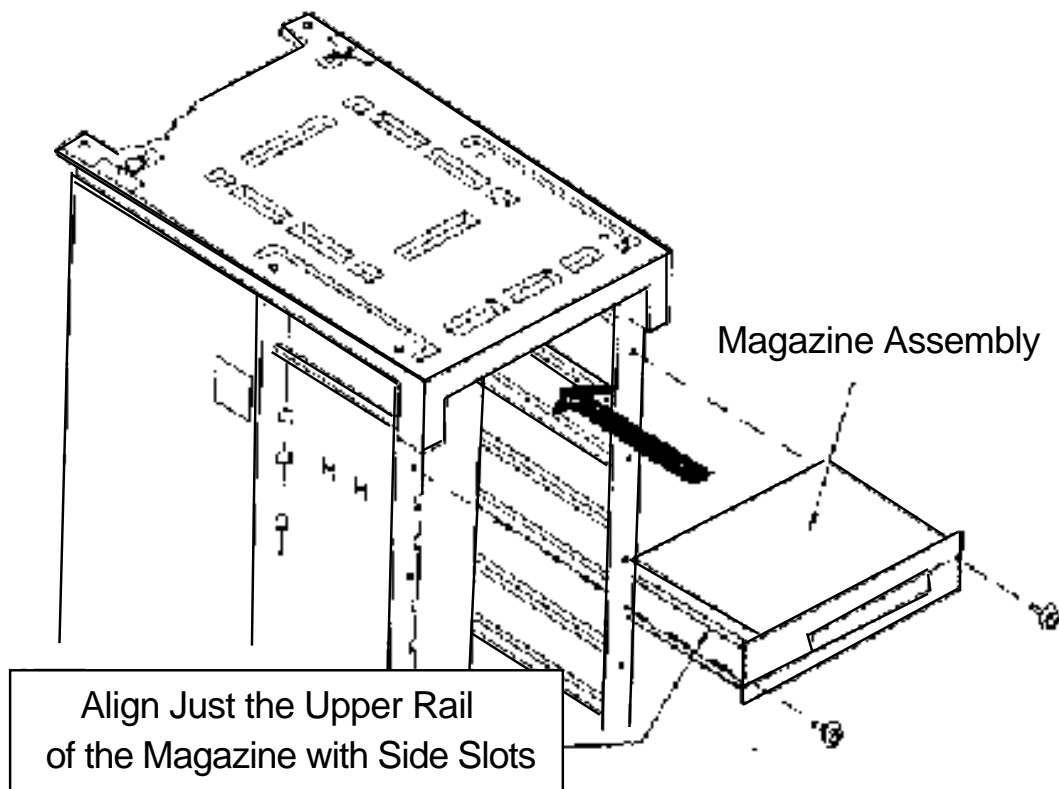
---

2. Remove the 14 T-25 screws holding the spacer panel in place (Figure C-8).
3. Remove the spacer.
4. Slide the seven magazines in the kit into their rails in the magazine rack.
5. Use the 14 screws removed from the old spacer to hold the additional magazines in place (Figure C-9).

Figure C-8 Magazine Spacer and Mounting Screws



**Figure C-9 Installing the Additional Magazines**



## **C.6 Reassembling the Optical Disk Library**

Follow the appropriate instructions, in reverse, to reassemble the optical disk library.

## C.7 Adding Product Change Labels

1. Stick the upgrade product serial number label on the top rear of the rail frame to the right of the existing product serial number label.
2. Stick the service information label on the lower rear outside panel above the existing labels.
3. Remove the 60C nameplate on the front bezel and replace it with the 100C nameplate, or remove the 120T nameplate and replace it with the 200T nameplate.
4. Close and latch the front and rear doors.

## C.8 Initializing NVRAM

The non-volatile RAM on the autochanger controller PCA **MUST BE INITIALIZED** after firmware is changed or a new PCA is installed.

1. Set the default configuration—run `CONF 16; CLEAR` option.
2. Run `CONF 18; "CLEAR"` option.
3. Cycle power.
4. Run Test 10 to initialize the status of the elements.

## C.9 Testing Optical Disk Library Operation

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**Note**

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Do not load cartridges into the new slots, 89 - 144 until testing is complete.

---

Test the alignment of the mailslots.

1. Run Test 65, Calibrate Magazines. **THIS TEST REQUIRES A DISK IN THE MAIL SLOT.** The magazines must be empty.

To test magazine 12:

- a. With **READY** displayed, press **[OPTION]**. **TEST** displays.
- b. Press **[ENTER]**. **TEST 0** displays.
- c. Press **[NEXT]** until 65 displays.

- d. Press **ENTER**. ONCE \* displays.
  - e. Press **ENTER**. A flashing 1 displays.
  - f. Press **NEXT** until 12 displays.
  - g. Press **ENTER**. RUN 65 displays.
2. Repeat the sequence above for magazines 13 to 18.
- This test calculates a minimum and maximum clearance for each magazine. The test passes if clearance is 85 encoder counts (1 mm) up and down. Check INFO 24 (for magazine 1) through INFO 41 (for magazine 18) for actual values. INFO 24-41 give the values in hexadecimal.

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**Note**

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Each running of Test 65 takes approximately one minute.

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