StorageWorks™

Small Optical Disk Library (RW546)

Service Manual

EK–SOL46–SV. B01

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Revision Record

This Revision Record provides a concise publication history of this manual. It lists the guide revision levels, release dates, and reasons for the revisions. It also describes how the changes to affected pages are marked in the manual.

Revision Level	Date	Summary of Changes
EK–SOL46–SV. A01	March 1997	First Edition
EK–SOL46–SV. B01	October 1997	Corrects Table 5–1. Also adds recommended service kits and common resource parts to end of Chapter 5.

About This Manual

This manual describes how to install, configure, and maintain the small optical disk library RW546. It also contains a chapter describing the theory of operation.

Audience

This manual supports trained service personnel for the small optical disk library RW546.

Document Organization

This manual contains the following chapters:

Chapter 1: Product Information

Describes product features and possible configurations. Also contains a matrix of environmental specifications.

Chapter 2: Environmental/Installation/PM

Describes site requirements, general checkout procedures, and preventive maintenance.

Chapter 3: Product Configuration and Operation

Describes how to setup the RW546, connect to a host, and verify operation.

Chapter 4: Troubleshooting and Diagnostics

Describes how to use locally available error information plus external and internal tests to determine corrective action.

Chapter 5: Removal and Replacement

Describes how to remove and replace sub-assemblies in the RW546 enclosure. Also includes Field Replaceable Units (FRU's), recommended service kits, and common resource parts.

Chapter 6: Theory of Operation

Describes how the RW546 works and the relationship between the mechanical operation and command set execution.

Typographical Conventions

The following typographical conventions are used in this manual:

Italic Font - Italic font designates the title of a document and statements that need to be emphasized.

SERIF TYPE – denotes information that is displayed in the display window of the jukebox.

SAN-SERIF TYPE – indicates the key to press on the jukebox control panel

NOTES, CAUTIONS, and WARNINGS

NOTE

A note calls attention to information which can be helpful in understanding the operation of the product.

CAUTION

Caution calls attention to an operating procedure or practice which could result in damage to the product if not correctly performed. Do not proceed beyond this symbol until you fully understand and meet the indicated conditions.

WARNING

Warning calls attention to a procedure or practice which could result in personal in-jury if not correctly performed. Do not proceed beyond this symbol until you fully understand and meet the indicated conditions.

Reader Comments

DIGITAL is committed to providing the best products, and we consider our manuals to be important components of our products. Therefore, you are encouraged to submit your comments, suggestions, and corrections to help us improve our product documentation.

Please submit all comments and corrections to this manual on the Reader Comment Form included at the back of this manual.

Support and Services

Who to contact in the Americas

Information and Product Questions:	Local Sales Office / StorageWorks Hotline 1-800-786-7967
Installation Support:	Contact the DIGITAL Distributor where the Storage Solution was Purchased / Local Digital Sales Office.
DIGITAL Multivendor Customer Service (MCS)	
Installation	Contact the DIGITAL Customer Support Center (CSC).
Warranty	Contact the DIGITAL Customer Support Center (CSC) for warranty service after solution is installed and operating.
Remedial	Contact the DIGITAL Customer Support Center (CSC) **Note**: A Service Contract is recommended when the equipment is out of warranty. Contact the local DIGITAL Sales Office.
Customer Support Center (CSC)	1 800-354-9000

Who to contact in Europe

Information and Product Questions,	Contact the DIGITAL Distributor or reseller
Installation Support, and Installation:	from whom the Storage Solution was purchased.
For Warranty Service	See the Warranty Card packaged with the product.
For Remedial Service	Contact the DIGITAL Distributor or reseller from whom the Storage Solution was purchased. **Note**: A Service Contract is recommended when the equipment is out of warranty.

Who to contact in Asia Pacific

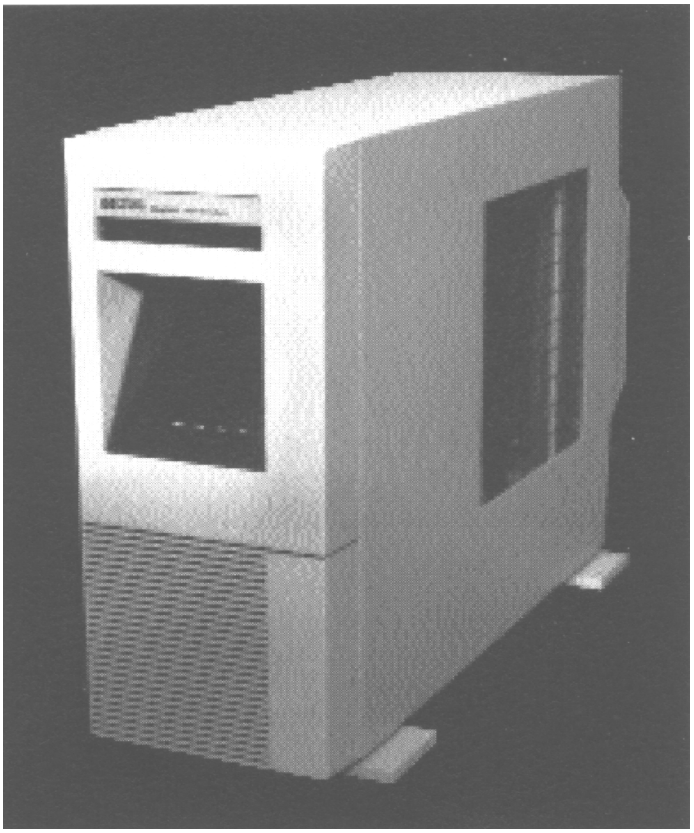
For all services, contact the DIGITAL Distributor or reseller from whom the equipment was purchased.

1

Product Information

This chapter provides general product information and lists important features and specifications. A matrix of environmental specifications provide parameters for several subassemblies.

Figure 1–1 The 16-Slot Optical Disk Jukebox - RW546



Product Features

The RW546 optical disk jukebox has the following features:

- direct on-line access to data
- data security through the ability to "lock" the jukebox, preventing disk removal.
- SCSI Interface
  - single-ended (RW545) or differential (RW546)
  - SCSI-2 command set
- autochanger reliability of:
  - 100,000 hours MTBF (Mean Time Between Failure)
  - 1,000,000 MSBF (Mean Swaps Between Failure)
- modular replacement of all major assemblies
- downloadable firmware for the drive mechanism and the autochanger controller PCA
- a Digital Signal Processor (DSP) based servo built into the drive mechanism for faster seek times and lower error rates
- split1 optics resulting in the use of a lighter optical head for faster and more accurate data access
- full read data caching to optimize system performance
- high reliability and data security when using Digital brand rewritable and write-once 5.25-inch optical disks
- Digital magneto-optical disks meet the standards given in Table 1–3.

Interface Configurations (RW545/RW546)

This jukebox is available with either a single-ended (RW545) or a differential (RW546) SCSI interface. These different product configurations are described in the following paragraphs.

NOTE

For an explanation of the product numbers for each configuration, see the "Product Matrix" in this chapter.

SCSI Interface Options

Single-ended SCSI Interface (RW545-ZA)

With a single-ended SCSI interface the total SCSI cable length allowed between peripherals and the host is 6 meters. The internal SCSI cable length of 1.45 meters must be included in this calculation.

A single-ended SCSI interface may be preferable when peripherals are physically close to the host and short SCSI cables are adequate to connect (or daisy-chain) them. An example of an appropriate use of a single-ended SCSI interface is when a host and several peripherals are daisy-chained and located in an upright cabinet, connected with 1-meter cables.

Differential SCSI Interface (RW546-ZA)

The differential SCSI interface specifies the use of a differential SCSI converter PCA. This PCA enables the jukebox to be connected to an external differential SCSI bus. The differential SCSI converter 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 25 meters usually allowed on a differential SCSI bus.

A differential SCSI interface is used when up to 15 meters of SCSI cabling is needed, and the peripherals need to be physically located farther apart than the single-ended SCSI interface allows. An example of an appropriate use of a differential SCSI interface is when a peripheral must be located in a different location than the host system for security reasons or for user convenience.

The differential SCSI interface has better noise immunity than the single-ended SCSI bus, so may also be used in a hardware configurations that produce noise on the SCSI bus.

The Optical Drive Mechanism

The optical drive mechanism (RWZ53) in the autochanger of the jukebox is a multifunction drive that can operate 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 can sense a rewritable or write-once disk by the formatting on the disk and enter the appropriate mode.

Table 1–1 Jukebox Capacities

Disk Capacity/Format	Max. Jukebox Capacity
594 Mbyte, 512 bytes/sector[1]	9.5 GBytes
650 Mbyte, 1,024 bytes/sector	10.4 GBytes
1.2 Gbyte, 512 bytes/sector[1]	19.2 GBytes
1.3 Gbyte, 1,024 bytes/sector	20.8 GBytes
2.4 Gbyte, 512 bytes/sector	36.8 GBytes
2.6Gbyte, 1,024 bytes/sector	41.6 Gbytes

NOTE

1X-Density disks are read-only compatible.

Magneto-Optical Disks

Magneto-optical disks are more durable, more reliable, removable, and cost far less per megabyte than magnetic disks. 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. Optical disk storage capacity varies depending on the disk type (see Table 1-1). Check the host system documentation to determine which disk format is supported. MO disks have 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. 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] Digital Operating Systems only support 512 bytes/sector.

Product Support

Host support for the jukebox is continually expanding; therefore, specific host system support cannot be provided accurately in this manual. However, host system support is documented in the current Product Service Plan, and the applicable Software Product Description (SPD).

Product Matrix

The following products are discussed in this manual. To determine the product and option numbers, find the product information labels located on the rear panel and check the corresponding information in the following table.

Table 1–2 RW546 Jukebox Product Matrix

Product Option	HP Designation	Description
RW546-ZA	Model 40XT (C1115H)	36.8 Gbyte (16 slot) multifunction optical disk library - includes two 2.6 Gbyte 5.25 inch multifunction drive and a differential SCSI interface
RW545-ZA	Model 40FX (C1100H)	36.8 Gbyte (16 slot) multifunction optical disk library - includes one 2.6 Gbyte 5.25 inch multifunction drive and a single-ended SCSI interface

Characteristics

The characteristics and environmental specifications for the RW546/RW545 are:

Optical Disk Jukebox/Drive Mechanism

Technical Characteristics (Drive)	
Rotational speed	3000 rpm (1X & 2X) 3600 rpm (4X)
Average seek	25.0 ms
Average access time	35 ms (4X disks) 33.3 ms (1X and 2X disks)
Burst transfer rate (asynchronous)	3 Mbytes/s
Burst transfer rate (synchronous)	5 Mbytes/s
Read transfer rate - max. sustained	For 1,024 bytes/sector– up to 1.69 Mb/s (4X disks) up to 1.24 Mb/s (2X disks) up to 1.04 Mb/s (1X disks)

Optical Disk Jukebox/Drive Mechanism (continued)

Technical Characteristics (Drive)	
Write transfer rate - max sustained	For 1,024 bytes/sector – up to 0.84) Mb/s (4X disks) up to 0.62 Mb/s (2X disks) up to 0.52 Mb/s (1X disks, read only) Burst transfer rate (synchronous) 5 Mb/s
Burst transfer rate (asynchronous)	3 Mb/s
Read/Write error rate	less than 1 block in error per 10^{14} bytes
Buffer size	1 Mb
Read Buffering	readaheads
Write Buffering	immediate reporting write re-ordering
Interface	SCSI-2 single ended /differential asynchronous/synchronous

Physical Characteristics (Jukebox)	
Height	495.3 mm (19.5 in.)
Width	220.1 mm (8.7 in.)
Depth	749.3 mm (29.5 in.)
Weight (net)	19.7 kg (43.5 lb.)
Weight (packaged)	26.3 kg (58.0 lb.)

Environmental Specifications

	Autochanger	**Drive**	**Media**
Temperature			
Operating	10° to 40°C	5° to 50°C	10°º to 60°C
Non-operating	-40° to 70°C	-40° to 70°C	-10° to 50°C
Temperature gradient	10°C per hour	10°C per hour	10°C per/hour
Transportation (<14 consecutive days)			-40° to 60°C
Humidity (non-condensing)			
Operating (relative)	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

Environmental Specifications (continued)

	Autochanger	Drive	Media
Shock (non-operating)			
End-use, handling (half-sine)	150 g (3 ms)	5 g (11 ms)	760 mm drop (to 2 mm vinyl-covered concrete)
Transportation (trapezoidal)	30 g (523 cm/s)	30 g (742 cm/s)	
Vibration (5-500 Hz range)			
Operating (max. accel.)	0.21 grms	0.3 grms	>0.21 grms
Non-operating random	2 g rms	3 g rms	
Non-operating swept-sine	0.5 g (0-peak)	1 g (0-peak)	
Altitude			
Operating	4,572 m (15,000 ft)		
Non-operating	15,240 m (50,000 ft)		
Acoustic emissions			
Operating	61.5 dB (L noise power emission level)		
Idle	47 dB (L noise power emission level)		
Particulates			
	Less than 200 micrograms/cubic meter particles suspended		
Electrostatic discharge			
Airgap (operating)	0 to 10 kV		
Airgap (non-operating survival)	0 to 25 kV		
Direct contact (operating)	0 to 4 kV		
Cooling requirements		15 CFM bi-directional through drive	

Power Requirements		
Line voltage	100-240V	
Line frequency	50-60Hz	
Power consumption (typical)	75 W	238.9 BTU
Power consumption (maximum)	100 W	341.3 BTU
Service Characteristics		
Mean time between failure	100,000 power-on hours	
Mean swaps between failure	1,000,000	
Mean time to repair	1 hour	
Preventive maintenance	none required	
Product Certifications		
Safety	EN 60950/IEC 950 UL 1950 listed or recognized CSA 950 TUV approved to VDE 0805 05.90	
Electromagnetic emissions	FCC 47 CFR Part 15 Subpart J - Class "B" EN 55022/CISPR 22, Level"B";SABS VCCI Level 2	
Laser	CDRH 21 CFR Chapter 1, Subpart J Registered IEC 825 TUV approved to VBG93, VDE 0837 TTL to Decision 472 S 4803 part 2 Approved Digital Optical Disks	

	1X	**2X**	**4X**
	Formatted Capacity		
1,024-byte sectors	650 Mbytes medium dependent	1.3 GBytes medium dependent	2.6 Gbyte
512-byte sectors	594 Mbytes medium dependent)	1.2 GBytes medium depend-ent	2.3 GBytes

Recording Characteristics (continuous-composite format)

	1X	2X	4X
Bytes per sector	512/1024(medium dependent)	512/1024 (medium dependent)	1024 (512)
Sectors per logical track	17/31(medium dependent)	17/31(medium dependent)	17(31)
Logical Tracks per surface	18751	37600 (logical)	75,732 (73,077)
Archival life	30 years	30 years	30 years

Table 1–3 Optical Disk Standards Met by Digital Optical Disks

Disk Type	Capacity/Format	Standard
Rewritable	**1X**– 594 Mbyte 512 bytes/sector 650 Mbyte 1024 bytes/sector.	Meets ANSI and ISO standards for Continuous-Composite (CC) format – conforms to ISO/IEC DIS 10089A; ISO/IEC 13549; ISO/IEC N828; ANSI X3.212-1994
	2X– 1.2 Gbyte 512 bytes/sector 1.3 Gbyte 1024 bytes/sector	Meets ECMA 184 standard for Continuous-Composite (CC) format.
	4X– 2.3 Gbyte 512 bytes/sector 2.4 Gbyte 1,024 bytes/sector	Meets ISO/IEC 10089A, 1560, and 14517 standards for Continuous-Composite (CC) format
	IX – 594 Mbyte 512 bytes/sector	ISO and ANSI standards for Continuous-Composite - Write-Once format (CCW)—conforms to ISO/IEC DIS 11560; ANSI x3.220-1994
Write-Once	**2X–** 1.2 Gbyte 512 bytes/sector 1.3 Gbyte 1024 bytes/sector	Meets ECMA 184 standard for Continuous-Composite - Write-Once format (CCW)
	4X– 2.3 Gbyte 512 bytes/sector 2.6 Gbyte 1,024 bytes/sector	Meets ISO/IEC 10089A, 11560, and 14517 standards for Continuous-Composite - (CC) format

2

Environmental/Installation/PM

This chapter provides site requirements and preliminary checkout procedures.

Environmental Requirements

NOTE

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

This optical disk jukebox 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 (18° F) per hour.

Primary Power/External Ground

The power outlet must supply a voltage range of 100 - 240 Vac at 50 - 60 Hz. Also, check the earth (safety) ground of the outlet.

Clearance Requirements

A minimum 70-80 mm (3 in.) is required behind the optical disk jukebox rear panel to allow air circulation.

Location Requirements

Position the autochanger away from sources of particulate contamination such as frequently-used doors and walkways, stacks of supplies that collect dust, and smoke-filled rooms.

Responsibilities

Customer site preparation/verification and installation are the customer's or reseller's responsibility. If the customer/reseller wants Digital to perform the site preparation/verification and/or installation, this should be contracted for on a time-and-materials basis.

For the RW546, see the Product Service Plan for further information on time-and-materials billings and for other support policies.

Refer to the following documentation for guidance:

- Small Optical Disk, RW546 Service Manual (this manual), Chapters 2 and 3
- Optical Disk Jukebox Family User’s Guide (EK-RW5XX-UG).
- Host system documentation

Checkout Procedure

Check that all materials are included with the jukebox (see the "Product Matrix" located in Chapter 1). If any items are missing, please contact your Sales Representative with the following information:

- original order number or unit serial number
- receiving address

If the unit is damaged, it will be repaired or replaced. Billing of the charges depends on whether the damage was caused by the carrier or the factory packaging. The cause of damage will be determined by the field service representative.

Problems determined to be caused by factory packaging should be reported, in detail, to the factory so a warranty claim can be submitted.

Be sure to include the product number and full serial number in any correspondence with Digital concerning the unit.

Preventive Maintenance

Cleaning Optical Disks

Cleaning an optical disk is needed more commonly on standalone drives than with autochangers because of the differences in their environments and usage. However, an autochanger may be used in such a way as to make disk cleaning necessary.

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

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 drive in the RW525 and could damage the optical drive mechanism.

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

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.

NOTE

SCSI -Connect Jukebox

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

As performance was declining as result of read/write problems, the disk was probably becomming 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.

3

Product Configuration and Operation

This chapter explains how to cable the optical disk jukebox and explains the configuration parameters.

Configuring and Operating the RW546 Jukebox

Assembly and Configuration

Setting up the optical disk jukebox is the customer/distributor's responsibility; however this service may be contracted for on a time-and-materials basis. Setup instructions for the SCSI-bus jukebox are in the Optical Disk Jukebox Family User's Guide (EK-RW5XX-UG) which is shipped with the product.

The following setup instructions are provided for situations where the customer has arranged for this service.

NOTE

Before you connect the optical disk jukebox to the host, verify that it is supported by the host. For the current list of which host systems support the SCSI-bus jukebox, refer to the Product Service Plan or applicable Software Product Description (SPD).

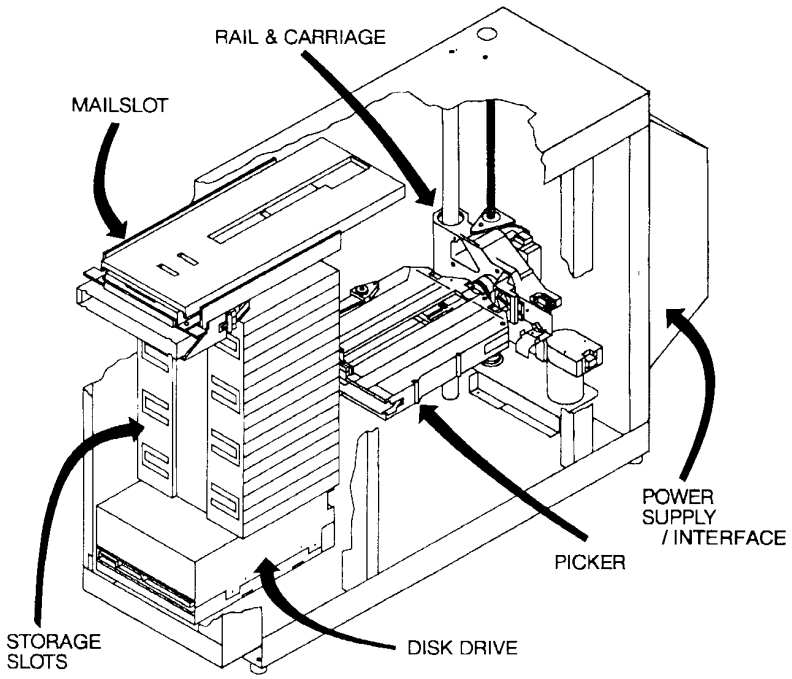
CAUTION

Remove the shipping screw from the jukebox before connecting power. Directions for removing the shipping screw are printed on the carton and its location is shown in Figure 3-3.

Jukebox Components

Figure 3–1 shows an overview of the major components in the jukebox.

Figure 3–1 Jukebox Major Components



Disk Drive	Either 1 or 2 multifunction optical disk drives for read/write data transfer; 4X versions hold either 1 or 2 drives). The drive(s) use unique SCSI address(es). See Chapter 6, “Theory of Operation”, for additional drive information.
Storage Slots	16 disk storage slots (can use 1X, 2X, and 4X disks).
Mailslot	Used to insert or remove optical disks from the jukebox.
Front Panel	Includes a control panel used to manage and display jukebox functions and a mailslot for inserting and removing disks. Control panel functions are described in the section, "Front/Control Panel Operations," later in this chapter.
Rear Panel (SCSI connect)	Includes SCSI connections, power cord connections and power switch (for power supply in the rear module), and on some models, a Differential SCSI interface converter (Differential to Single-Ended). Instructions for connecting the jukebox to the host system are in the applicable *User’s Guide*.
Rail and Carriage	Support the picker for its movement within the jukebox.
Picker	Rotates, flips, and transports optical disks to and from the storage slots, mailslot, and optical drive.

Removing the Shipping Screw

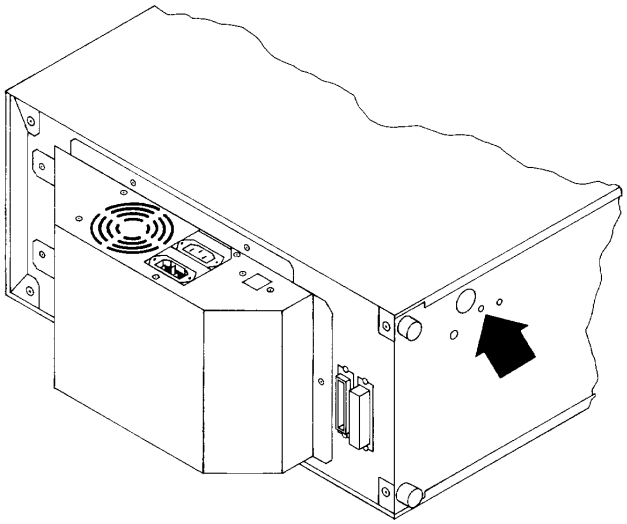
CAUTION

Remove the shipping screw from the jukebox before connecting power. Directions for removing the shipping screw are printed on the carton and its location is shown in Figure 3–2 below.

NOTE

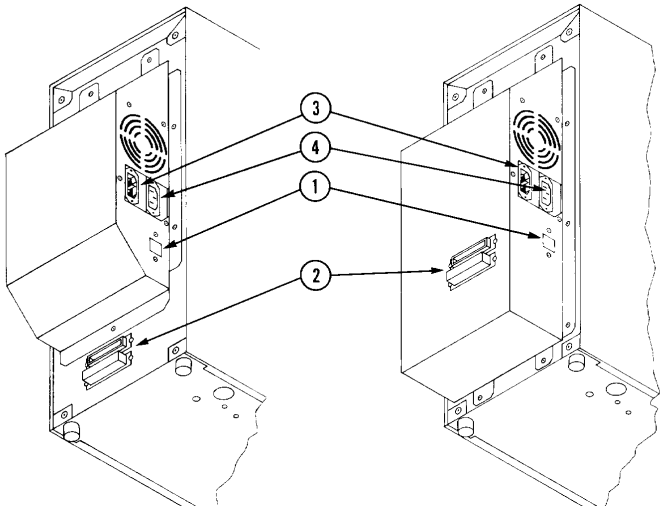
The customer should be encouraged to save the packaging and shipping screw for possible future shipment.

Figure 3–2 Shipping Screw Location (SCSI-connect jukebox shown)



Rear Panel Features and Controls

Figure 3–3 Rear Panel – RW546



Single-ended **Differential**

1.	Power switch	Used to switch on or off all power to the jukebox.
2.	SCSI connectors	Two SCSI bus format connectors that allow SCSI devices to be daisy-chained. If no other SCSI device exists after the current device on the chain, a terminator must be connected to the unused connector.
3.	Power connector	Connection for power cord.
4.	Auxiliary Power Port	Used for auxiliary power connections.

CAUTION

Do not use Auxiliary Power Port for connections that draw more than three amperes.

Connecting an Uninterruptable Power Supply (UPS)

To fully protect against data loss in the event of a power failure, Digital recommends the use of an uninterruptable power supply (UPS). The UPS must be a central UPS used by the entire computer system.

NOTE

The RW525 does not have a UPS connector.

If a power failure occurs during a write operation, the UPS must be able to continue to supply power to the jukebox/computer system until the data in the optical drive's buffer can be written to an optical disk.

For the best protection, the customer should choose the type of UPS that provides a communication link between the UPS and the computer system. With this type of connection, the computer system is informed when power is being supplied by the UPS and can issue commands to automatically write any data from buffers to disk. The computer then refuses any additional write commands until regular power is restored.

CAUTION

If the UPS does not provide a communication link between the UPS and the computer system, an operator will have to shut down the computer system (stop any new writes) before the UPS battery power is drained.

If the UPS is connected to the jukebox, the following power requirements must be met:

Table 3–1 UPS Power Requirements

Volt-Amps	Watts
125 Volt-Amps (typical)	75 Watts (typical)
180 Volt-Amps (maximum)	110 Watts (maximum)

Connecting the SCSI Cables

The jukebox may have either a single-ended or a differential SCSI interface. The total allowable cable lengths for each interface type are as follows:

Table 3–2 SCSI Cable Lengths

Interface Type	Total Allowable Cable Length
Single-ended SCSI	4.55 meters
Differential SCSI	15 meters

To connect the SCSI cables, do the following steps.

CAUTION

Do not switch off power to any peripheral on the SCSI bus if the bus is active. Switching off power to a peripheral on an active bus may cause data loss and/or indeterminate bus states.

1. Make sure the host computer and the jukebox are switched off.
2. Locate a SCSI cable.
3. Locate an appropriate SCSI terminator (differential or single-ended).

If this jukebox is the only (or last) SCSI device on a bus, connect the SCSI cable to one jukebox connector and put the terminator on the other jukebox connector.

If this jukebox will be a SCSI device in the "middle" of the bus, connect the SCSI cable to one connector on the jukebox and connect the cable that goes to the next SCSI device onto the other connector.

NOTE

Do not exceed the total SCSI cable length limitations.

Connecting Power

CAUTION

Verify that the shipping screw has been removed before connecting power. Directions for removing the shipping screw are printed on the carton and its location is shown in Figure 3–2.

1. Check to make sure that the power switch located on the rear module is switched off.
2. Plug the power cord into the AC line connector located on the rear panel. (Figure 3–3.)
3. Plug the power cord into the power outlet.
4. Press the power switch located on the rear module to the ON position.

   Initially, the control panel displays **TESTING**. Once the poweron test completes, the control panel displays **READY**.

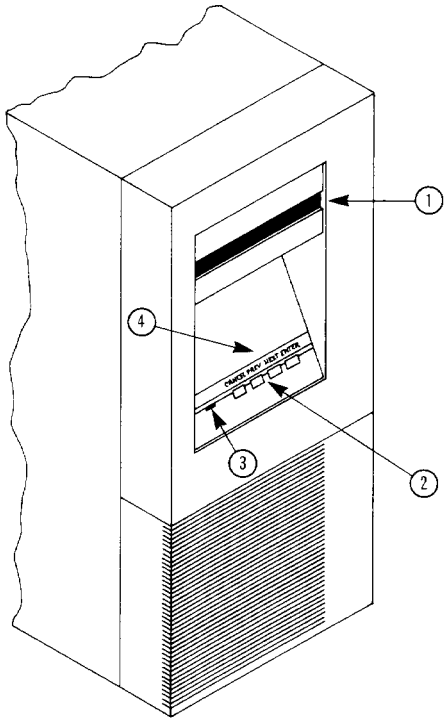
NOTE

A sequence of tests are run when the jukebox is first switched on. The **READY** status on the control panel indicates that the unit is in sound condition. If a **TEST FAIL** status appears on the control panel display, refer to Chapter 4, "Troubleshooting and Diagnostics," for information on how to resolve the problem.

Front Panel/Control Panel Operations

Refer to the following illustration for the location of the front panel controls and features:

Figure 3–4 Front Panel



1.	Mailslot	Allows you to insert or remove optical disks.
2.	Selection Control	Press these buttons to perform the desired operation. **CANCEL** is pressed to cancel the current operation or choice.

		NEXT is pressed to display the current operation options available such as "LOAD", "TEST", "Information, "Configuration, and "EJECT", and "SCSI ID", or to scroll the displayed choice forward by one. **PREV** is pressed to scroll the displayed choice backward by one. **ENTER** is pressed to choose the displayed selection.
3.	Status Indicator	Lit when a read, write, erase, or seek operation is done. It is also lit during poweron selftest.
4.	9-Character Display	Displays information about the current operation. Generally you press **PREV** or **NEXT** to control the selections. Once your selection is displayed, you press **ENTER**. You may press **CANCEL** to cancel your selection.

Host Configuration

Once the jukebox is connected to the host system and the device address is set, you are ready to prepare the host system to access the jukebox.

To determine if the host you are connecting to supports this device and for further installation information, check the following documents:

- The Product Service Plan or the applicable Software Product Description (SPD).
- *Installing the Optical Disk Library System* (shipped with the jukebox).
- host system documentation

Autochanger Configuration Choices

The following table lists the available choices for configurations. Chapter 3, "Product Configuration and Operation," explains how to access and set these configurations.

Table 3–3 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 save 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.
	Configurations 15 - 20 require a security code. See "Setting a New Security Code" in the section "Securing the Optical Disk Jukebox" in Chapter 3.		
15	Prevent Media Removal (security code required)	Off	On = No Mailslot I/O Off = Normal Mailslot I/O
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	Set Configurations (security code required) Clears/zeros these logs: #4 - Drive Load Count #5 -Poweron Hours #9 - Move Count	Save	Clear - clears/zeros the specified logs. Save - maintains the specified logs until Clear is configured.

Table 3–3 Autochanger Configuration Choices (continued)

No.	Function	Default	Options
	#12 - Flip Count #14 - Mailslot Rotations		
20	Poweron Cartridge Security(security code required)	Off	On - maintains the status of configuration 15 through a power cycle or power fail. Off - Configuration 15 is not maintained through a power cycle or power fail.
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 Load Count Log (Information Log 4).	Save	Clear - clears the drive Load Count Log immediately. Save - saves the drive Load Count Log until CLEAR is configured.
27	Report Recovered Error	Off	On - reports any SCSI-level errors to the host. Off- does not report SCSI-level errors to the host.
31	Secured Mailslot Rotation (security code required; see "Setting a New Security Code " "Securing the Optical Disk Jukebox" in Chapter 3	Off On -	Off - Normal mailslot operation. The mailslot rotates IN when in the section the configuration is set to ON or a Prevent Medial 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.

Table 3–3 Autochanger Configuration Choices (continued)

No.	Function	Default	Options
32	Mailslot Rotation (security code required; see "Setting a New Security Code" in the section "Securing the Optical Disk Jukebox" in Chapter 3.)	Off	Off - Normal mailslot operation. If the host sends a Rotate Mailslot command and this configuration 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	Select Inquiry Mode	Off	Off - Selects downloadable inquiry mode. Required when connected to Digital Operating System. This changes mode of auto controller PCA. On - selects standard inquiry HP mode.
41	Usage of Drive Parity Bit	On	Off - Changes inquiry to Digital mode. Required when connected to Digital Operating System. On - Changes inquiry to HP mode.
42	Select Check/No Check on Move to Picker	On	On - Normal "bump" check on a move to the picker to verify existence of a cartridge. Off - "Bump" check to verify existence of a cartridge is not done (an OEM configuration).
66	Zero all RAM (requires password 9-9-9)	Save	Save - RAM remains unchanged. Clear - Zeros all RAM locations and reboots.

CAUTION

When this configuration is set to "clear," the product ID and the vendor ID are cleared. DO NOT perform this configuration operation!

Setting a Configuration ("CONF")

Follow these steps if you wish to set an autochanger configuration. A complete list of the available configurations is given in Chapter 7, "Reference."

1. With **READY** displayed, press **NEXT** until **CONF*** displays.
2. Press **ENTER**. **CONF0** displays. (The **0** is blinking.)
3. Press **ENTER**, **NEXT**, or **PREV** until **CONF##** displays (where "**##**" is the configuration number you want to change.)
4. Press **ENTER**.

   Some configurations require a security code. If prompted, enter the security code. (**NO CONFIG** displays if you entered the wrong code.)
5. Press **NEXT** or **PREV** until the value you want appears in the display.
6. Press **ENTER** once your choice displays. **SET** displays briefly followed by **CONF*.**
7. Press **CANCEL** twice to return to **READY**.

Displaying Information Logs ("INFO")

Information logs are listed in Chapter 7, “Reference.”

1. With **READY** displayed, press **NEXT** until **INFO*** displays.
2. Press **ENTER**.
3. Press **NEXT** or **PREV** until the desired log number displays. See Chapter 7 for a complete listing of information logs.
4. Press **ENTER**. The log information displays.

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

Choosing Tests and Displaying Results (“TEST”)

> **NOTE**
>
> A complete listing of diagnostic tests is given in Chapter 7, "Reference."

1. With **READY** displayed, press **NEXT**. **TEST*** displays.

2. Press **ENTER**. **TEST0** displays.
3. Press **NEXT** or **PREV** until the needed test number displays.
4. When you press **ENTER** for the chosen test, **ONCE** displays.

   You may accept **ONCE** by pressing **ENTER** or press **NEXT** or **PREV** to choose **10**, **100**, **1000** or **LOOP** test repetition times.

   LOOP indicates that the test runs continuously until **CANCEL** is pressed or the unit is switched off.

   NOTE

   All tests except test 39 may be stopped by pressing **CANCEL**. The current test iteration completes. To stop test 39, press **CANCEL** twice.

5. Once you press **ENTER** for the number of test iterations, **TEST##** displays (where "**##**" is the test number).

   The test runs. If no problems are encountered, the message **PASS##** displays.

   You may press **CANCEL** to get back to the **READY** state; or, you may press **ENTER** to perform another test.

   If a problem occurs during the test, the message **FAIL##** displays. Press **ENTER** to gain information about the failure. An **ERROR##** displays. Relevant information is stored in the Autochanger Error Log (Log 0).

   Press **CANCEL** to exit this display.

Setting the SCSI Address

> **NOTE**
>
> Determine what SCSI device addresses are currently in use on the host system. You can then correctly determine what available SCSI addresses to use for the optical drive mechanism and the autochanger controller.

The default address settings are as follows:

- autochanger controller - SCSI ID 3
- optical drive mechanism - SCSI ID 4

If you want to change either the SCSI (single drive) or the address, follow these steps.

> **NOTE**
>
> Pressing **CANCEL** at any time will return you to the **READY** state or will take you back one step each time it is pressed.

1. With **READY** displayed, press **NEXT** until **SCSI ID#** displays.
2. Press **ENTER**, **AC ID 3** displays.

   This is the autochanger controller address. If you want to change this address, press **ENTER**, otherwise press **NEXT** to display **DRV ID 4** and then press **ENTER**.
3. Press **NEXT** or **PREV** until the address you want is displayed.
4. Press **ENTER**. The address you chose is now set.
5. Press **NEXT** until either **UPDATE** or **CONFLICT** displays.

   If **CONFLICT** displays, the drive and controller have been set to the same address and one of them must be reset.

   If **UPDATE** displays and you are satisfied with the addresses you have selected, press **ENTER**.
6. Record the new address setting(s) for future reference.

Securing the Jukebox

In its default condition, the jukebox 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, the following procedures might be considered:

- setting a new security code periodically and limiting the number of people who know the security code
- implementing security configurations 15 and 20 which restrict disk insertion and removal
- locating the jukebox in a physically secure environment

Setting a New Security Code

NOTE

A security code of 0-0-0 was set at the factory. Although the customer may change this code to another for security reasons, this change should only be done if the customer has a real security need. If the code is something other than default, service personnel will have to contact the administrator of the jukebox to gain access.

When setting a new security code, the old code (or default code, **0-0-0**, if none has been set) must be keyed in first and then the new code keyed in.

1. With **READY** displayed, press **NEXT** until **CONF*** displays.
2. Press **ENTER**. **CONF0** appears in the display window (**0** is flashing).
3. Press **NEXT** until **CONF17** is displayed.

   You are now prompted to enter the old or default security code.

4. Press **ENTER**. **CODE1** and a flashing **0** is displayed.
5. Press **NEXT** until the first number of the old or default (**0**) security code is displayed.
6. Press **ENTER**. **CODE2** and a flashing **0** is displayed.
7. Press **NEXT** until the second number of the old or default (**0**) security code is displayed.
8. Press **ENTER**. **CODE3** and a flashing **0** is displayed.
9. Press **NEXT** until the third number of the old or default (**0**) security code is displayed.
10. Press **ENTER**. **SET** is displayed if you entered the old number correctly.

NO CONFIG is displayed briefly and then **CODE17** is displayed if a mistake was made in keying in the old security code. Follow steps 4 through 9 again.

NOTE

It is a good idea for the customer to write down the new security code prior to entering it into the jukebox.

Follow these steps to enter the new security code:

1. Press **ENTER**. **NEW1** and a flashing **0** is displayed.
2. Press **NEXT** to choose the first number of the new security code.
3. Press **ENTER**. **NEW2** and a flashing **0** is displayed.
4. Press **NEXT** to choose the second number of the new security code.
5. Press **ENTER**. **NEW3** and a flashing **0** is displayed.
6. Press **NEXT** to choose the third number of the new security code.
7. Press **ENTER**. **SET17** is displayed.

Restricting Disk Insertion and Removal

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

- **CONF15** – when this is set to ON, you cannot insert or remove disks without a security code.

- **CONF20** – when this is set to ON, the **CONF15** status is maintained when a power fail occurs. Also, the reserved status on mounted surfaces is maintained if the autochanger power fails.

When setting **CONF15** or **CONF20**, the display prompts you for a security code. This security code is **0**-**0**-**0** (default) or the one set by the customer using **CONF15**.

Setting CONF 15 or CONF 20

1. Press **NEXT** until **CONF*** displays, then press **ENTER**.
2. Press **NEXT** or **PREV** until **CONF15** or **CONF20** displays.
3. Press **ENTER**. **CODE1** and a flashing **0** displays.
4. Press **NEXT** or **PREV** until the first security code number displays.
5. Press **ENTER**. **CODE2** and a flashing **0** displays.
6. Press **NEXT** or **PREV** until the second security code number displays.
7. Press **ENTER**. **CODE3** and a flashing **0** displays.
8. Press **NEXT** or **PREV** until the third security code number displays.
9. Press **ENTER**.
10. Press **NEXT** or **PREV** to select **ON** or **OFF**.
11. Press **ENTER**. **SET 15** or **SET 20** displays.

Controlling Mailslot Rotation

Configurations 31 and 32 allow control of mailslot rotation as described on the next page. (See also "Setting a Configuration" at the beginning of this section.)

NOTE

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

The following configurations allow control over the mailslot's position.

- **CONF31 –** when this is set to ON and **CONF15** 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 **CONF15** (requires a security code to 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 autochanger is full, the mailslot will only open for an eject command.

- **CONF32 –** 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 **ENTER** on the jukebox control panel displays an **MS** or **CLOSE MS** message. When the open or close message displays, press **ENTER** to toggle the mailslot open or closed.

If the autochanger is full, the **OPEN/CLOSE MS** is not displayed and the mailslot will only open for an eject command.

Moving or Shipping the RW546 Jukebox

Moving the Jukebox a Short Distance

To move the optical jukebox a short distance (down the hallway or to another floor in the building) do the following steps. If you want to ship this jukebox, see "Shipping the Jukebox" on the next page.

1. Unmount (unreserve) any disk surfaces from the host system if necessary.
2. If there is a disk loaded into the drive mechanism, eject the disk from the drive and return it to its storage slot.

CAUTION

Failure to eject a disk from the optical drive prior to transport could result in damage to the drive mechanism.

Do not switch off the optical disk jukebox or unplug the AC power cord until you are sure that the SCSI bus is inactive. Switching off power 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.)

NOTE

Before moving the jukebox to its new location, make sure all environmental requirements listed in Chapter 2 have been met and the power outlet has been checked to ensure that the proper voltage is available for the drive.

1. Switch off the power switch (located on the back panel).
2. Remove the power cord and SCSI cable connections.
3. Carefully move the jukebox to its new destination.
4. Connect the jukebox to the host.
5. Reconnect the power cord.
6. Configure the jukebox to the host. (Refer to your host system manual for configuration information.)

Shipping the Jukebox

To ship the unit, do the following steps.

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

> **CAUTION**
>
> Failure to eject all disks from the optical drive and storage slots prior to transport could result in damage to the drive mechanism and/or auto-changer.

3. Run **TEST23** to position the picker for shipping.
   a. Press **NEXT** until **TEST*** appears. Press **ENTER**.
   b. Press **NEXT** until **TEST23** appears. Press **ENTER**.

> **CAUTION**
>
> Do not switch off power or unplug the AC power cord from the optical jukebox until you are sure that the SCSI bus is inactive. Switching off the jukebox or unplugging the power cord when the SCSI bus is active can cause data loss and/or in-determinate bus states. (Check the host system reference manuals for information on checking the status of the SCSI bus.)

4. Press the power switch (located on the rear module) to the "OFF" position.
5. Remove the power cable and SCSI cable connections.

6. Lay the jukebox on its side and replace the shipping screw (see Figure 3-5).

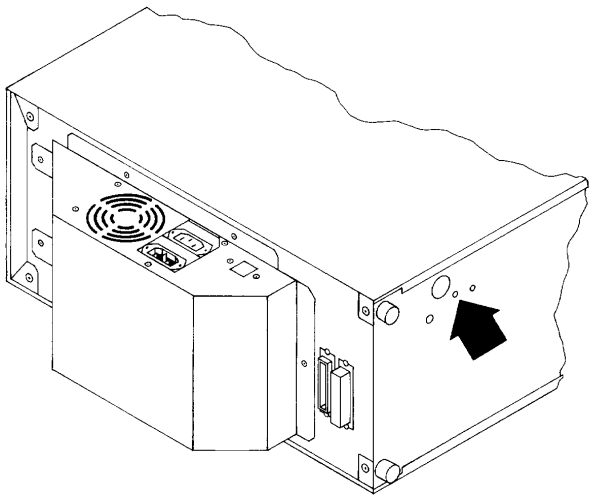
NOTE

If the shipping screw has been misplaced, you can use a cap screw with the following specifications:

- 6/32 UNC-2B screw
- 1-3/4 inches long

7. Repackage the autochanger in its original shipping carton and have the unit shipped in the same manner in which it was received.

Figure 3–5 Replacing the Shipping Screw



4

Troubleshooting and Diagnostics

This chapter lists possible problems which might occur during installation and provides possible solutions for those problems. Diagnostic tests are also discussed.

Operation/Installation Troubleshooting - RW546 Jukebox

There are four main sections in this chapter:

- Operation/Installation Error Information – Lists common problems encountered during operation and installation of the optical disk jukebox 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 control panel display. This level of troubleshooting is used when "hard" (repeatable) errors are encountered. (Intermediate-level troubleshooting.)
- Error Information through SCSI Commands – Error messages and log information available by issuing SCSI commands via an external host computer. This level of troubleshooting is used when "soft" (intermittent) errors are encountered. (In-depth level troubleshooting.)
- External Diagnostic Utilities and Internal Tests – Information about the available internal and external diagnostics used to aid in the troubleshooting process.

Operation/Installation Error Information

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

Diagnostic Test Command Descriptions

Sequence Tests

The sequence tests are described in Table 4–1.

Table 4–1 Sequence Tests

No.	Test Name	Description
1	Poweron	Checks all digital data paths and normal machine operation. This test runs the same se quence of TESTS as when initiated by an actual power on, but does NOT do all operations (see below). Sequence Order: 3 - Controller Test — - Motor Connection Test (no number) 5 - Initialize Mechanism X - 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 where it came from. This attempt could fail (poweron sequence would fail). POWERON ONLY. 10 - Initialize Element Status (if needed). 38 - "Light Show" in the indicators of the control panel. Mailslot rotation (if not secured). This rotation could fail (poweron sequence would fail). POWERON ONLY.
2	Wellness Test	Checks out the general capability of the autochanger. Needs one loaded cartridge; drive and mailslot empty. Sequence Order: 1 - Poweron Test 11 - Mechanical Exerciser Test
3	Controller Test	This sequence is run by the autochanger controller at poweron to check out all paths, and operation of the servo and autochanger motor circuitry. 31 - ROM Checksum Test 33 - Non-Destructive RAM Test 32 - RAM Checksum Test 34 - SCSI Interface Controller IC Test 36 - Motor Control IC Test 37 - Drive Connect Test

Table 4–1 Sequence Tests (continued)

No.	Test Name	Description
5	Initialize Mechanism	Prepares the unit for movement. Sequence Order: Initialize RAM variables to defaults 50 - Find Home

Exerciser Tests

Table 4–2 Exerciser Tests

No.	Test Name	Description
10	Initialize	Functions the same as the SCSI Initialize Element Status command. This test physically Status scans the entire unit to determine which storage slots contain disks and if the drive contains a disk.
11	Mechanism	Makes a combination of moves with a Exercise Test PASS/FAIL result. This exerciser is a sequence of other exerciser tests-- 12, 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 all storage slots are full. Needs one cartridge loaded; the drive and mailslot must be empty.
12	Carriage Picker Move Test	Moves the carriage/picker assembly the full length of the rail. Returns PASS/FAIL. No cartridges are required.
14	Flip Test	Makes a combination of moves with a PASS/FAIL re sult. It does several flips at various locations. No car tridges are required.
15	Storage Slot Test	Makes a combination of moves with a PASS/FAIL re sult. 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 cartridge loaded.
16	Drive I/O Test	Makes a combination of moves with a PASS/FAIL re sult. It moves a cartridge from a randomly- chosen full slot to the drive, with a random flip. It then moves the cartridge back to its original slot with its original orien tation. Returns an error code 57H, "Invalid Configura tion", if there are no cartridges loaded into the unit or if the drive already contains a disk. Needs one cartridge loaded; the drive must be empty.

Table 4–2 Exerciser Tests (continued)

No.	Test Name	Description
17	Mailslot I/O	Makes a combination of moves with a PASS/FAIL re sult. 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 Configura tion" if there are no cartridges loaded into the unit or if the mailslot is full. Needs one cartridge loaded; the 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 chosen provides 1/Parameter speed (e.g., Parame ter=3 runs the motors at 1/3 of full speed). May only be run through the SCSI interface.
19	Zero Maximum Force Log	The maximum force log is initialized to all 0s.
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 containing a cartridge.
25	Empty Picker	Moves a cartridge from the picker to the first empty stor age 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	The entire error log is initialized to all zeros.

Table 4–3 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 FIND HOME sequence 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 unless interrupted by power failure. To run correctly, this test must shut down the servo system; as a result, a FIND HOME sequence 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 and will report **PASS**.
35	Not used	Always returns **PASS**.
36	Motor Control Chip Test	Exercises the registers of the motor control chip. To run correctly, this test shuts down the servo system; a FIND HOME sequence runs when this test finishes.
37	Drive Connect Test	Checks for expected drive configuration. This is done by polling the drive connect signal on the drive. This line is grounded at the drive end if the drive is con nected. If the physically-connected drive does not match the expected configuration, 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 **CANCEL** twice to exit.
40	Not used	Always returns **PASS**.
41	SCSI Connector Loopback Test	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 and will report error FEH "Test Did Not Run."
42	Optical Sensor	(The same display is used for Tests 42, 43, and 44.)

Table 4–3 Electronic Core Tests (continued)

No.	Test Name	Description
43	Test	Same as 42.
44	(interactive - if done through the control panel)	The display shows **MOO VO BO**. MOO - is the portion of the display that applies to the mailslot sensor test. The two "OO"s are two sections of the display next to the "M" The left "O" is an indi cator for the FRONT mailslot sensor; the right "O" is an indicator for the REAR mailslot sensor. When a sensor is blocked in a manual test, the corresponding segment will fill with lit LED segments. VO and BO are not used. The "O" position in each of these portions of the display will always show clear. No FRU is returned.
45	Not used	Always returns **PASS**.
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 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 mechanism recalibration, establishes which picker side is up, and determines the reference points in the picker travel path. 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, 36, 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.

Table 4–3 Electronic Core Tests (continued)

No.	Test Name	Description
65	Calibrate Magazines	Calculates a min/max clearance of the second (near-center) storage slot in each storage slot group. Storage slots 2,6,10, and 14 must be empty.) Requires a disk in the mailslot. The test passes if clearance for each of the storage slots tested is 85 encoder counts (1 mm) up and down. (See Info 23 for actual values.) The test returns:
Byte 2-3 - clearance up		
Byte 4-5 - clearance down.		
66	Clear Magazine Min/Max	Clears the value calculated in test 65.
67	Calibrate Mailslot	Calculates a min/max clearance for the mailslot. A disk must be in the mailslot. The test passes if clearance is 85 encoder counts (1 mm) up and down. (See Info 23 for actual values.) The test returns:
Byte 2-3 - clearance up		
Byte 4-5 - clearance down.		
68	Clear Mailslot Min/Max	Clears the value calculated in test 67.
71 to 74	Reserved	For production use only.
75	Not used	Always returns **FAIL**.
76 to 80	Reserved	For production use only.

Accessing and Running Internal Diagnostic Tests

To display test information and to choose tests to execute, access the ***TEST*** option using the following steps.

1. With the autochanger power on and in the ***READY*** state, press **NEXT**. ***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 ***OPTION*** is pressed or the unit is powered off.

NOTE

Any test may be stopped, at any time, by pressing **CANCEL**. The jukebox will stop the test after it completes its current activity. (Test 39, the key test, requires **CANCEL** to be pressed twice.)

5. Once you have pressed **ENTER** for the number of times the test will repeat, ***RUN nn*** displays (where nn is the test that was selected).
6. At this point the test runs. If no problems are encountered, the message ***PASS nn*** displays. You may press **CANCEL** to get back to the ***READY*** state; or, you may press **ENTER** to run another test.

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.

Operation/Installation Troubleshooting – SCSI-Connect Jukebox

- **Operation/Installation Error Information**

  Lists common problems encountered during operation and installation of the optical disk jukebox, 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 control panel display. This level of troubleshooting is used when "hard"(repeatable) errors are encountered. (Intermediate-level troubleshooting).

- **Error Information through SCSI Commands**

  Error messages and log information available by issuing SCSI commands via an external host computer. This level of troubleshooting is used when "soft" (intermittent) errors are encountered. (In-depth level troubleshooting.)

- **External Diagnostic Utilities and Internal Tests**

  Information about the available internal and external diagnostics used to aid in the troubleshooting process.

Error and Performance Logs

The logs listed below are accessible from the control panel by using the INFO option. Chapter 4, has instructions for using these information logs.

Table 4–4 Information Logs

No.	Log Name	Description
0	Autochanger Error Log	A time-stamped history of diagnostic test errors. The message logged for each error shows the error and the possible Field Replaceable Units (FRUs) that may have failed and caused the error. Displays as follows: Err *n y - n* th error; actual error code FRU A - suspect FRU #1 FRU B - suspect FRU #2 FRU C - suspect FRU #3 Test *n* - test that failed *abcdefgh* - time stamp
1	Firmware Version number.	Displays the current autochanger firmware number version.
2	Element Status changer	Displays the status (**EMPTY** or **FULL** of the seted auto element. Displays three numbers: First Number = Element number 0 = picker 1 = drive 0 = mailslot 1 - 26 = storage slots Second Number = Element type 1 = picker 2 = storage slot 3 = mailslot 4 = drive Third Number = Data mask 00 = empty 01 = full
3	Software Clock	Displays the current "count" in seconds of the software clock (hexadecimal)
4	Drive Load Count	Displays the number of cartridge loads into the drive
5	Poweron Hours	Displays the number of hours the operation switch is ON

The term "Move" used in Logs 6 - 10 means SCSI- level moves by the picker mechanism.

Table 4–4 Information Logs (continued)

No.	Log Name	Description
6	Current Move Success Count	Displays the number of successful moves since the most recent autochanger hard 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. The log also shows retry counts corre sponding 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 **CANCEL** is pressed. A - Moves done B - Retries C - Automatic recoveries D - Hard errors
12	Display Flip Count	Displays total number of picker flips
13	Display Translate Count	Displays total number of picker translates (This will always return "0".)
14	Display Mailslot Rotation Count	Displays total number of mailslot rotations
15	Number of Drives	Displays the number of disk drives in the unit. (This will always return "1".)
16	Drive 1 SCSI Address	Displays the drive's SCSI address
17	Drive 2 SCSI Address	Displays drive 2 SCSI address (2-drive, 4X-capacity versions only).
20	Sensor Height	Remains for backward compatibility with previous code. This value, rather than being read from sensor in front of the drive, is computed from the top limit of the picker travel point. Value is hexadecimal format.
21	Picker Cone Angle	This value is determined from historical data. Value is hexadecimal format.

Table 4–4 Information Logs (continued)

No.	Log Name	Description
22	Stack Tilt	Not valid for this model of jukebox. Reports 0.
	Minimum Clearance	Minimum clearance for cartridge insertion into a
23	Storage Slot group 1	magazine or storage slot. Up/down clearance is
24	Storage Slot group 2	the value calculated by test 65.
25	Storage Slot group 3	Up clearance/down clearance(hexadecimal)
26	Storage Slot group 4	
	Storage slot groups are groups of 4 magazine slots starting at the drive end of the chassis and numbered upwards.	Example: **00DC 0028** = 220,40 **FFEC 0014** = -20,20
60	Extended INFO	Displays (in the following order):
	Log	Entry n n - Entry number
		MC – Number of moves that have occurred since error logs were rezeroed
		MACRMV n n – Macro-Move ID number
		MVIDI n n –- First Micro-Move ID number
		ERRIDI n n – First Micro-Move error code
		MVID2 n n – Second Micro-Move ID number only shown if applicable)
		ERRID2 n n – Second Micro-Move Error code
		Source n n – Source element number of disk involved in failing move
		Dest n n – Destination element number of disk in volved in failing move
61	Firmware Checksum	For manufacturing use only

The Find Home Sequence and Information Logs

Specific Steps of the FIND HOME Sequence

NOTE

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.

The following sequence lists each large movement in the FIND HOME sequence. If there is a problem during a movement, the most likely hardware errors are listed after the movement in descending order of probability.

Hardware error numbers and recovery procedures are listed in Chapter 4.

NOTE

When running the FIND HOME sequence, you can see what the mechanism is attempting when an error occurs by setting RETRIES to 1 (test 27). When limited to a single execution, the autochanger is prevented from entering any error recovery sequences. If you want to examine movements more closely, set the speed to half or quarter speed (test 21 or test 22).

Possible errors are not accessible or displayed through the control panel. Errors returned are micro-move errors. Micro-move errors are explained in Chapter 6, "Theory of Operation."

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.

Error numbers are in hexadecimal notation.

1. **Clear the picker of any obstructions that would prevent carriage/picker movement.** (MMID# 56 to 6E)

   Possible error: – 40--unable to free the picker fingers in preparation for carriage motion

2. **Clear an area large enough to enable a flip to take place.** (MMID# 49 to 4C)

   Possible error: – 44--carriage motion failure during the FIND HOME sequence

3. **Initialize the picker fingers by pulling the fingers back to a hard stop and calibrate flip mechanism.** (MMID# 4D, 4F, 7, 8)

   Possible error: – 45--unable to free the picker fingers

4. **Initialize the carriage/picker position by moving it toward the drive end of the unit until it hits a hard stop**. (MMID# 47, 48)

   Possible error: – 46--carriage motion failed while initializing home position during the FIND HOME sequence

5. **Find orientation of the picker** (MMID# 1, 2, 53, 54, 7, 8)
   Possible error #1: – 4A--motion error while determining the orientation of the picker
   Possible error #2: – 4C--failed flip motion during the Find Home sequence
6. **Determine if there is a cartridge in the picker by plunging the fingers against a hard stop** (MMID# 2, 52, 5)
   Possible error #1: – 4D--motion error while checking for cartridge in the picker
7. **Flip the carriage/picker assembly with the nut facing upward if necessary** (MMID# 1, 2, 7, 8)
   Possible error: – 4C--failed flip motion during find home sequence
8. **Initialize the mailslot.** (MMID# 2, 2B to 35)
   Possible error: – B0--mailslot will not rotate

Table 4–5 List of Micro-Move Reference Table

Move ID (hex.)	Description
0	No motion; no commands pending
1	Carriage motion; full speed; away from drive
2	Carriage motion; full speed; toward the drive
3	Carriage motion; move fingers forward during full speed; away from the drive
4	Carriage motion; move fingers forward during full speed; toward the drive
5	Full speed finger motion
7	Pull fingers back to depress flip button
8	Flip
9	Verify flip complete
A	Push fingers out to release flip button
11	Move fingers toward storage slot; with intent to grab cartridge
12	Detect cartridge in storage slot before grab and during Initialize Element Status
13	Take up the slack in the fingers before grabbing the cartridge
14	Pull cartridge back from storage slot with cartridge
15	Push cartridge forward into storage slot
16	Detect cartridge in storage slot after insert
17	Pull fingers back from storage slot after releasing cartridge
18	Move fingers toward drive; prepare to grab cartridge
19	No motion; waiting for the drive to eject the cartridge
1A	Carriage shake; to assist the cartridge ejected from the drive to slide into the picker

Table 4–5 List of Micro-Move Reference Table (continued)

Move ID (hex.)	Description
1B	Move fingers toward drive with intent to grab cartridge
1C	Pull fingers back from drive with cartridge
1D	Insert cartridge into drive until slider engages
1E	Insert cartridge into drive after slider has engaged
1F	Move fingers with cartridge toward the drive, determining distance of cartridge in drive. Look for drive to accept cartridge
20	Drive failed to accept the cartridge; pull cartridge back
21	Drive accepted cartridge; release cartridge and pull fingers back
22	Carriage motion during mailslot access
23	Move fingers toward mailslot with intent to grab the cartridge
24	Detect cartridge in the mailslot before grab
25	Take up the slack in the fingers before grabbing the cartridge
26	Pull cartridge back from the mailslot with cartridge
27	Carriage motion during mailslot access
28	Push cartridge forward into the mailslot
29	Detect cartridge in the mailslot after insert
2A	Pull fingers back from mailslot after releasing cartridge
2B	Move leadscrew tab toward actuator arm before pulling mailslot in
2C	Carriage motion toward actuator arm where mailslot is engaged before pulling mailslot in
2D	Move leadscrew tab to mailslot actuator arm before pushing mailslot out
2E	Carriage motion toward actuator arm where mailslot is engaged before pushing mailslot out
30	Release tension on the mailslot rotate arm
31	Release tension on the mailslot rotate arm
32	Rotate the mailslot
33	Rotate the mailslot
34	Verify the rotation of the mailslot is complete
35	Rotate the mailslot when rotational position unknown
36	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
37	Pull fingers back during test for a cartridge
38	Move fingers at full speed during test for a cartridge
39	Positioning before and after test for a cartridge in drive

Table 4–5 List of Micro-Move Reference Table (continued)

Move ID (hex.)	Description
3A	Check for a cartridge in the drive
3D	Move carriage to drive bang position
3E	Verify the presence of a cartridge by pressing cartridge against drive face
3F	Short carriage motion to check for cartridge sticking out of a storage slot after insertion (toward drive)
40	Short carriage motion to check for cartridge sticking out of a storage slot after insertion (away from drive)
41	Short carriage motion to check for cartridge sticking out of the drive after insertion (toward drive)
42	Short carriage motion to check for cartridge sticking out of the driver after insertion (away from drive)
43	Short carriage motion to check for cartridge sticking out of the drive during error recovery (toward, then away from drive)
47	Carriage motion toward drive; looking for hard stop in the FIND HOME sequence
48	Release forces after finding hard stop
49	Carriage motion away from drive finding room to flip in FIND HOME sequence
4A	Fast carriage motion toward drive to flip position
4B	Carriage motion toward drive finding room to flip in FIND HOME sequence
4C	Fast carriage motion when flip area found in needed direction
4D	Slow flips during FIND HOME sequence
4E	Push fingers slowly out of picker after flips in FIND HOME sequence
4F	Check for picker belts in FRU isolation tests, or slow finger motions during error recovery
50	Carriage motion toward the drive looking for hardstop before measuring carriage travel

Table 4–5 List of Micro-Move Reference Table (continued)

Move ID (hex.)	Description
51	Verify the maximum required carriage travel from the drive
52	Test for presence of cartridge by pushing against hard stop
53	Long carriage motion during carriage/picker assembly calibration
54	Short carriage motion during carriage /picker assembly calibration (fine measure)
57	Error occurred while inserting cartridge, push cartridge farther into storage slot
59	Move fingers toward storage slot during storage slot recovery
5A	Pull fingers back from storage slot during storage slot recovery
5B	Carriage motion during drive recovery
5C	Carriage motion during storage slot recovery
5D	Carriage motion during drive insert recovery
5E	Slowly push fingers out then in during drive recovery
5F	Drive recovery
60	Drive recovery
61	Short carriage motions during drive recovery (wiggle motion)
62	Long carriage motion in drive recovery (toward, then away from the drive)
64	Pull fingers back into picker during recovery
65	Pull fingers back from storage slot during storage slot recovery
66	Carriage motion while testing for cartridge in drive during drive insert recovery
67	Pull back fingers from drive after releasing cartridge during recovery
68	Move fingers with cartridge towards drive, using short steps, look for drive to accept the cartridge during recovery
69	Carriage motion during initial recovery (away from drive)
6A	Carriage motion during initial recovery (toward drive)
6B	Push fingers out of picker during initial recovery
6C	Pull fingers back into picker during initial recovery
6D	Carriage motion during initial recovery (away from drive)
6E	Carriage motion during initial recovery (toward the drive)
6F	Checking for carriage motor belt in FRU isolation tests

CAUTION

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.

Table 4–6 Operation Errors – SCSI Connect Jukebox

Task	Problem/Symptom	What to do
Communicating host<-->jukebox	Can't get the host to recognize the jukebox.	• Check to make sure the jukebox is supported on the host operating system. • Check to make sure the autochanger was installed and configured as described in the *User's Guide* and the appropriate host system manuals. • Check the SCSI connections. • Check the SCSI interface address as it relates to the device files.
Changing the drive address	Changed drive address but new address is not recognized.	After changing an address, the autochanger power and/or the host system power may need to be cycled for the new address to be recognized.(Refer to the host system documentation for information on setting peripheral addresses and shutting down the host system.)
Inputting Security Code	Security code forgotten or misplaced for the autochanger.	First, try the default security code (0-0-0). If the security code is not set to the default, replace the Autocontroller PCA. ("Removal/Replacement" in Chapter 5.)

Table 4–6 Operation Errors – SCSI Connect Jukebox (continued)

Task	Problem/Symptom	What to do
Loading Disks	Disk inserted in mail-slot, but the display reads **ERROR, EMPTY**, or **MISLOAD**	Remove the disk from the mailslot, mail-slot and try inserting it again. Push the disk in, shutter-end first, so that the disk is flush with the jukebox front panel.
Powering on	The optical disk juke-box won't poweron.	• Check to make sure the power cord connections are tight. • Check that the power switch is ON. • Check to make sure the power out let is operating. • Replace the power cord with a known good one. • Replace the power supply module.
	Poweron selftest fails.	• Verify that the shipping screw has been removed. • Turn the unit off, then turn it on again. Observe the poweron test result. If the unit continues to fail, use the error code to begin trouble-shooting. (See the "Poweron Selftest" section following this table.)
	Does not boot cor-rectly.	Make sure the boot disk is ON, spun up, and ready before applying power to the host computer. The auto-changer and the host may then be powered on in any or-der.
Power fail	Just the autochanger power fails.	When power returns, unmount and re-mount all disk surfaces. Do not eject any disks until the surfaces are un-mounted/unreserved.
	Autochanger power fails while a disk is in the drive.	If you need to remove the disk before power can be resupplied to the drive, the eject tool can be used to recover the disk. See the instructions for using the eject tool later in this chapter.

Table 4–6 Operation Errors – SCSI Connect Jukebox (continued)

Task	Problem/Symptom	What to do
	Host computer power fails and the auto-changer stays on.	After the host reboots, file system check any write-mounted surfaces.
	Both the host system and autochanger power fail.	After the host reboots, file system check any write-mounted surfaces. See the following CAUTION note.
	CAUTION Do not eject disks from the autochanger until all mounted surfaces are un-mounted. To prevent disks from being removed after a power failure, set configuration 20 (Poweron Cartridge Security) to "ON." See the sections, "Autochanger Configuration Choices" and "Control Panel Operations" in Chapter 3 for an explanation of configuration 20 and how it is set.	
Reading the front panel display window	No display messages appear.	• Make sure that the power switch is ON. • Check that the power cord is conected. • Check AC input. • Check the control panel cable connections. • Replace the control panel PCA. • Replace the autochanger controllerPCA. • Replace the power supply.

Table 4–6 Operation Errors – SCSI Connect Jukebox (continued)

Task	Problem/Symptom	What to do
Reading/writing magneto-optical disks	Can't write to the disk.	• Check the file system access permissions. • Check the write-protect tab on each disk side to assure write-enabled status. • Check to make sure the disk was initialized • Check that the disk file system was mounted correctly. • Refer to the "Optical Disk Cleaning" section in this chapter.
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** or **MISLOAD** error message displays.	Remove the disk from the mailslot and try to remove the desired disk again.
	The unit's power failed while a disk was in the drive.	• Try powering on the unit. If successful, use file system check command. • If poweron 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 the "Powering On" and "Power Fail" sections in this table. • If it is critical to remove the drive before power is restored, see "Using the Eject Tool to Remove a Disk from the Drive" in this chapter.

Power-on Selftest

CAUTION

When the optical disk jukebox is powered on and selftest 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 selftest failure results.

CAUTION

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.

To run the poweron selftest, do the following steps:

1. Insert a formatted disk into the drive either from a storage slot location or through the mailslot/control panel.
2. Place jukebox power switch to ON.

If the poweron selftest completes successfully, the front panel will show **READY** and both LEDs on the drive will turn off. If poweron selftest fails, an error message appears on the front panel display and the drive fault LED will remain lit.

The drive LED lights can be seen through the window on the side of the jukebox or you may take the cover and side access panel off to get a clearer view.

To remove the cover and side access panel

1. Remove power from the jukebox.
2. Remove the four T-25 screws that hold the cover to the rear panel.
3. Slide the cover toward the rear of the unit. Slots on the bottom of the cover will slide off their rests. Pull the cover back and away from the chassis.
4. Remove the eight T-25 screws holding the side panel on the right side of the jukebox. Remove the side panel.
5. Apply power to the jukebox.

Run the power-on selftest as explained previously.

Optical Disk Cleaning - All Jukeboxes

NOTE

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

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.

NOTE

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.

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 drive in the RW525 jukebox and could damage the optical drive mechanism.

Using the Eject Tool to Remove a Disk From the RWZ53 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 RWZ53 optical drive, you can order:

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

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

Length	50 mm
Width	2.45 mm
Thickness	0.5 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 do the following 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.

> **CAUTION**
> 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.

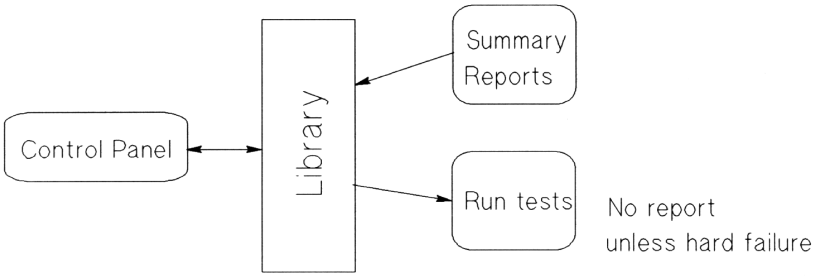
Troubleshooting Using the Control Panel and Observation

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

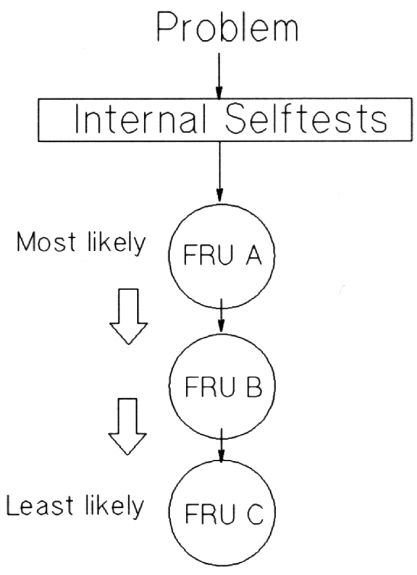
Figure 4–1 Information and Tests Through the Control Panel



The Autochanger Lists the First "Possibles"

At poweron, 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.

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 failure from which a recovery was made. This test sequence, called the "FRU Isolation Test" (test 60), can also be run from the control panel. Similar to its automatic operation, this test sequence only points out ("isolates") FRUs if there has been a hard failure.

What the FRU Isolation Test Assumes –

- There was a failure.
- The cause of the failure was physical (either mechanical or electrical).
- 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).

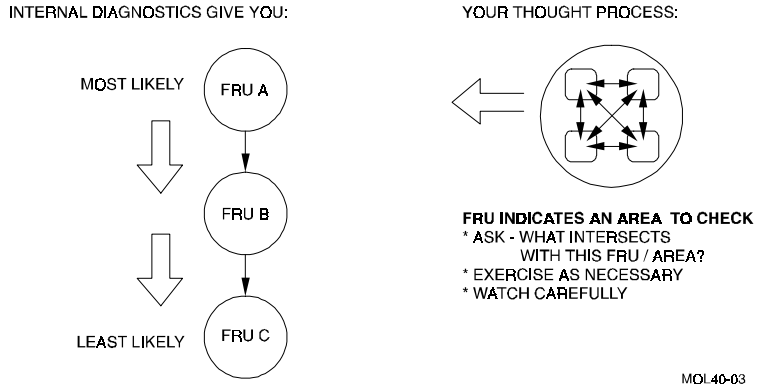
Whenever the initialization sequence is run, FIND HOME is attempted. If the "home" position cannot be found, the FRU isolation test is run automatically. When the FRU isolation test is run from the control panel, the FIND HOME sequence is run.

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.

An example:

Say 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 picker 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.

The FRU Isolation Test Sequence

The following list traces the execution (Test 60) 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 loss. (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 with the leadscrew nut completely at the end of the leadscrew.(eliminates the picker belt)
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 lead-screw 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.

Error and Performance Logs

The optical autochanger 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. (If more in-depth troubleshooting is needed, an external diagnostic (such as DOSDASS2) may be used to access the error and information logs. See the next section, "Error Information through SCSI Commands.")

Procedure

To display information about the autochanger (e.g., the error log or move success log) access the **INFO** option using the following steps.

1. With the autochanger power on and in the **READY** state, press **NEXT**. **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**
> 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.

Verification/Recovery from Hardware Errors

When a hardware failure occurs, a message is displayed on the control panel. If the failure occurs during the poweron sequence, **FAIL1** is displayed. If the failure occurs at some other time, **MISLOAD** or **FAIL0** 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.

> **NOTE**
> Instructions for running internal diagnostic tests are given in the "Diagnostics" section of this chapter."

The following table 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 FRUs logged by the FRU isolation test as a guide to determine the problem. Replace the FRU(s) as necessary.

Table 4–7 Recovery for Specific Hardware Errors

Error Code (hex)	Error Description	Recovery Procedure
00	No error	No action
AUTOCHANGER CONTROLLER PCA ERRORS The first step is to make sure all the cables are fully inserted		
q		
01 ROM Checksum Error	Run test 31 – ROM Checksum Test–verify failure.	
03 RAM test error	Run test 33 – RAM Test -- verify failure.	

Table 4–7 Recovery for Specific Hardware Errors (continued)

04 Microprocessor Test Error	Run test 30 -- Microprocessor Operation Test -- verify failure,
05 Controlled Area of RAM Checksum Error	**Recovery procedures for error codes 05, 06, and 07 are handled in the same manner:** Recycle Power -- verify failure. **If error repeats--** Run configuration 16 -- resets default values. Recycle power. **If error repeats:** Replace autochanger controller PCA (FRU 01). Poweron -- check fix.
06 Illegal interrupt seen by microprocessor	See error 05.
07] llegal CPU exception seen by microprocessor	See error 05.
09 Firmware Error	Run test 3 -- Controller Test – (may not be able to duplicate).
	Visual Inspection is not possible for errors OB to 13. All recovery procedures for SCSI interface-specific errors are handled in the same manner: Run test 34--SCSI Interface Controller Chip Test -- verify failure.
0B SCSI Controller Register Error	See note above.
0C SCSI Controller IC's RAM Failed	See note preceeding error 0B.

Table 4–7 Recovery for Specific Hardware Errors (continued)

0D SCSI Controller Message Error	See note preceeding error 0B.
0E SCSI Controller Command Error	See note preceeding error 0B.
0F SCSI Controller Kill Error	See note preceeding error 0B.
10 SCSI Controller FIFO Error	See note preceeding error 0B.
11 SCSI Controller Target Sequence Error	See note preceeding error 0B.
12 SCSI Controller Command Sequence Error	See note preceeding error 0B.
13 SCSI Controller Status Sequence Error	See note preceeding error 0B.

Table 4–7 Recovery for Specific Hardware Errors (continued)

LOOPBACK ERRORS - (SCSI-connect only)	
	All recovery procedures for loopback errors are handled in the same manne: Run test 41 – (SCSI Connector Loopback Test using loopback connector 88780-60095)[1] – verify failure for tests 2C thru 2E.
18 SCSI Connector Loopback Error in DBO or I/O	See note above.
19 SCSI Connector Loopback Error in DB1 or C/D	See note preceeding error 18.
1A SCSI Connector Loopback Error in DB2 or MSG	See note preceeding error 18.
1B SCSI Connector Loopback Error in DB3 or REQ	See note preceeding error 18.

[1] Loopback connector (88780-60095) is not a Digital stocked part.

Table 4–7 Recovery for Specific Hardware Errors (continued)

1C SCSI Connector Loopback Error in DB4 or ACK	See note preceeding error 18.
1D SCSI Connector Loopback Error in DB5 or ATN	See note preceeding error 18.
1E SCSI Connector Loopback Error in DB6 or SEL	See note preceeding error 18.
1F SCSI Connector Loopback Error in DB7 or BSY	See note preceeding error 18.
20 SCSI Connector Loopback Error in DBP or RST	See note preceeding error 18.
2B Timer A did not count down as expected	See note preceeding error 18.

Table 4–7 Recovery for Specific Hardware Errors (continued)

MOTOR CONTROL IC ERRORS	
	Recovery procedures for motor control IC errors are handled in the same manner: Run test 36 (Motor Control Chip Test) – verify failure for tests 2C thru 2E.
2C Failed read/write test to motor control IC	See note above.
2D Motor Control Loopback Test failed	See note preceeding error 2C
2E Motor Control IC RAM Test failed	See note preceeding error 2C
DRIVE CONNECT ERRORS	
	On error codes 37, 38, 39 be sure to check: • drive cabling • good contacts • no cut or exposed wires
37 Neither drive 1 or 2 connected	See note above. Run test 37 -- Drive Connector Test– verify failure.
38 Drive 1 not connected	See note preceding error 37. Run test 37 -- Drive Connector Test– verify failure.
39 Drive 2 not connected	See note preceding error 37. Run test 37. – Drive Connector Test – verify failure.

Table 4–7 Recovery for Specific Hardware Errors (continued)

MECHANISM ERRORS	
	Check carriage/picker for free motion. The carriage should travel easily along the rail.
3C Unspecified failure	See note above. Run test 11 – Autochanger Mechanism Exercise Test. On error – go to error code in this table.
3E Unspecified servo failure	See note preceeding error 3C. Run test 11 – Autochanger Mechanism Exercise Test – verify failure.
	Recovery procedures for error codes 40 through 46 are handled in the same manner: **Check the following assemblies in the autochanger for loose labels or other obstructions – picker, mailslot, drive, and storage slots.** Run test 50 – Find Home Sequence – verify failure
40 Unable to free picker fingers for carriage motion	See note above.
41 Unable to verify picker is at home position	See note preceeding error 40.
42 Unable to find home position	See note preceeding error 40.
	Recovery procedures for error codes 40 through 46 are handled in the same manner: **Check the following assemblies in the autochanger for loose labels or other obstructions – picker, mailslot, drive, and storage slots.** Run test 50 – Find Home Sequence – verify failure

Table 4–7 Recovery for Specific Hardware Errors (continued)

44 Carriage motion failure during Find Home sequence	See note above.
45 Unable to free picker fingers	See note preceeding error 44.
46 Carriage motion failed while initializing Home position (during Find Home)	See note preceeding error 44.
48-49 Carriage motion failed during carriage/picker assembly calibration	Run test 51 -- Carriage/Picker Assy. calibration -- verify failure.
	Recovery procedures for error codes 4A through 4D are handled in the same manner:
	Run test 50--Find Home Sequence -- verify failure.
4A Motion error while determining orientation of the picker	See note above.
4B No sensor found	See note preceeding error 4a.
4C Failed flip motion during Find Home sequence	See note preceeding error 4a.

Table 4–7 Recovery for Specific Hardware Errors (continued)

4D Motion error checking for cartridge in the picker	See note preceeding error 4a.
	Recovery procedures for error codes 4E through 52 are all handled in the same manner: **Check the optical sensor, if necessary**. Run test 51 – Carriage/Picker Assy Calibration – verify failure.
4E-4F Unable to measure height of sensor	See note above.
50 Excessive tilt of the carriage/picker assembly (away from the drive)	See note preceeding error 4E.
51 Excessive tilt of the carriage/picker assembly (toward drive)	See note preceeding error 4E.
52 Excessive cone angle on picker	See note preceeding error 4E.
54 Unable to complete an interrupted move (at powerup)	Run test 60 – FRU Isolation Test - verify failure. If no error, monitor for reoccurrence. 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.

Table 4–7 Recovery for Specific Hardware Errors (continued)

EXERCISER TEST ERRORS	
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 DOSDASS2**
5A Invalid test configuration	No FRUs failed. Can't do the selected test (elements reserved)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 inter-face. Use DOSDASS2**
5C Shipping diagnostic run with cartridges in drive mechanism	No FRUs failed - Shipping warning. Take all disks out of the optical drive mechanism.

Table 4–7 Recovery for Specific Hardware Errors (continued)

CALIBRATION SENSOR SYSTEM ERRORS	
60-61 Home sensor failed	Run test 51 -- Carriage/Picker Assy Calibration -- verify failure.
MAILSLOT/STORAGE SLOT ERRORS	
	Check for loose labels or other obstructions in errors that involve the mailslot (B0-B2).
B0 Mailslot will not rotate	See note above. Run test 17 – Mailslot I/O Test – verify failure.
B1 Inside mailslot sensor failed	Run test 43 – Mailslot Sensor Test – verify failure.
B2 Mailslot will not accept or release cartridge	Run test 17 – Mailslot I/O Test – verify failure.
	Check for loose labels or other obstructions in errors B3 and B4. Also, make sure that the storage slots are not skewed.
B3 Storage slot will not accept or release cartridge	Run test 15 – Storage Slot Test – verify failure
B4 Outside mailslot sensor failed	Run test 43 – Mailslot Sensor Test – verify failure.

Table 4–7 Recovery for Specific Hardware Errors (continued)

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**
B8 Drive access error	See note above. Run test 16 – Drive I/O Test – verify failure. Access the drive logs.
B9 Drive 2 access error	Run test 16 – Drive I/O Test – verify failure. Access the drive logs ***Drive logs are available only through the SCSI interface. Use DOSDASS2***.
DRIVE EJECT ERRORS	
BC Drive 1 access failure	Run test 16 – Drive I/O Test – verify failure. Access the drive logs. ***Drive logs are available only through the SCSI interface. Use DOSDASS2.***
BD Drive 2 access failure	Run test 16 – Drive I/O Test – verify failure. Access the drive logs ***Drive logs are available only through the SCSI interface. Use DOSDASS2.***

Table 4–7 Recovery for Specific Hardware Errors (continued)

FRU DETECTION TEST ERRORS	
	Check carriage/picker for free motion. The carriage should travel easily along the rail; you should be able to easily flip the picker using the picker belt. **Recovery procedures for all FRU detection test errors are handled in the same manner:** Run test 60 – FRU Isolation Test – verify failure.
C8 Unable to gain proper servo control of motors	See note above.
C9 Unable to move picker motor	See note preceeding error C8.
CA Unable to move carriage motor	See note preceeding error C8.
CB Unable to move either motor	See note preceeding error C8.
CC Unable to find a hard stop while turning the picker motor	See note preceeding error C8.
CD Unable to find a hard stop while turning the carriage motor	See note preceeding error C8.
CE Excessive force needed to move the carriage leadscrew	See note preceeding error C8.

Table 4–7 Recovery for Specific Hardware Errors (continued)

MISCELLANEOUS ERRORS	
FC	The test can only be run from the control panel.
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.

Getting Error Information through the SCSI Bus

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

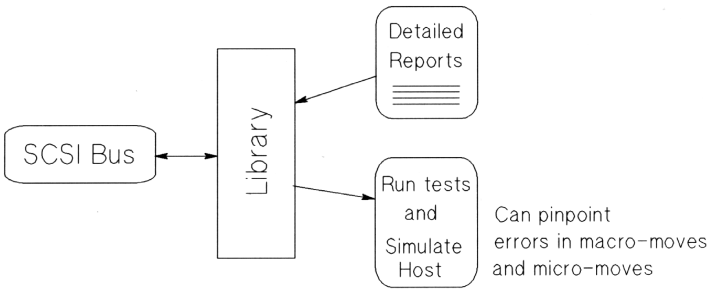
- Troubleshooting Using the Control Panel and Observation - This method is usually used in situations where you have a hard error.
- Troubleshooting Through the SCSI Bus - This method is used in situations where you have a soft or intermittent error.

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 drive; which cannot be done through the control panel.

An external utility is needed to read the data on the SCSI bus. Hewlett-Packard offers a diagnostic utility called DOSDASS2 that provides this capability. This utility is available from the Digital Customer Support Center at CXO.

Figure 4–4 Information and Tests Through the SCSI Bus



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

Offline Diagnostics for Digital Optical Storage.

This offline diagnostic, DOSDASS2 can be used to access the above information through the SCSI bus.

In addition, refer to the following tables, also contained in this guide:

- **Request Sense Command Table**

  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 Table**

  These tables show the error and move information which is stored in various logs during autochanger operation and when running internal diagnostics.

Diagnostics

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

The main type of diagnostics available for the jukebox 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. Instruction for running these tests are provided in this chapter.

Offline Diagnostics - A diagnostic utility called DOSDASS2 is available to authorized service organizations from Digital for accessing the jukebox through the SCSI bus.

DOSDASS2 fully exercises either standalone multifunction optical drives or autochangers that contain multifunction optical drives.

Internal Diagnostic Tests

An extensive set of internal diagnostic tests is available for the autochanger. 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 autochanger controller PCA.

Autochanger Mechanism Core Tests (50 - 75) run basic tests of the autochanger mechanism. These tests make combinations of moves that can help to detect the source of fail

Procedure

To display test information and to choose tests to execute, access the **TEST** option using the following steps.

1. With the autochanger power on and in the **READY** state, press **NEXT**. **TEST#** displays.
2. Press **ENTER**. **TEST0** 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 **OPTION** is pressed or the unit is powered off.

> **NOTE**
>
> Any test may be stopped, at any time, by pressing. **CANCEL** (Some tests require that **CANCEL** be pressed twice.) The unit will stop the test after it completes its current activity.

5. Once you have pressed **ENTER** for the number of times the test will repeat, **R ONCE UNnn** displays (where **n ONCE n** is the test that was selected).
6. At this point the test runs. If no problems are encountered, the message **PASSnn** displays. You may press **CANCEL** to get back to the **READY** state; or, you may press **ENTER** to run another test.

If a problem occurs during the test, the **FAILnn** message displays. Press **ENTER** to gain information about the failure. An **ERRORnn** displays. The error log stores the FRU information, information, **TESTnn**, and a time stamp.

5

Removal and Replacement

This chapter describes how to remove and replace repairable assemblies of the RW546 jukebox.

Contents

Field-Replaceable Assemblies

The jukebox contains the following major assemblies:

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

WARNING

DO NOT DISASSEMBLE the optical drive mechanism.

The optical drive mechanism becomes a Class 3B laser device when disassembled. If the drive is disassembled, exposure to the invisible laser beam and hazardous invisible laser radiation could result in blindness.

NOTE

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

ESD Precautions

The optical disk jukebox 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.

Tools Required

The following tools are needed for assembly/disassembly of the autochanger:

- Torx® driver with the following bits: T-10, T-15, T-25
- needle-nosed pliers
- Pozidriv® magnetized screwdriver
- flatblade screwdriver

Assembly/Disassembly Procedures

WARNING

Disconnect the power cord before taking the jukebox apart to prevent possible electrical shock.

CAUTION

Do not switch off power to the jukebox until you are sure the SCSI bus is inactive. Switching off the jukebox when the SCSI bus is active can cause data loss and/or indeterminate bus states.

When servicing the jukebox, be sure that disk cartridges are not moved from their original slot locations. If you need to remove the cartridges, record their SLOT LOCATIONS and ORIENTATION so they can be replaced to their ORIGINAL positions. Failure to follow this practice results in a serious loss of file system integrity.

Service Access

1. Remove power from the jukebox. Switch off the power switch on the power module on the rear panel.
2. Unplug the power cord from the power module.
3. Remove the jukebox cover by removing the four T-25 screws on that hold the cover to the rear panel.
4. Slide the cover toward the rear of the unit. Slots on the bottom of the cover will slide off their rests. Pull the cover back and away from the chassis.
5. Remove the 8 T-15 screws on the top, bottom and sides of the access panel. Remove the access panel.

Figure 5–1 Removing the Outside Cover

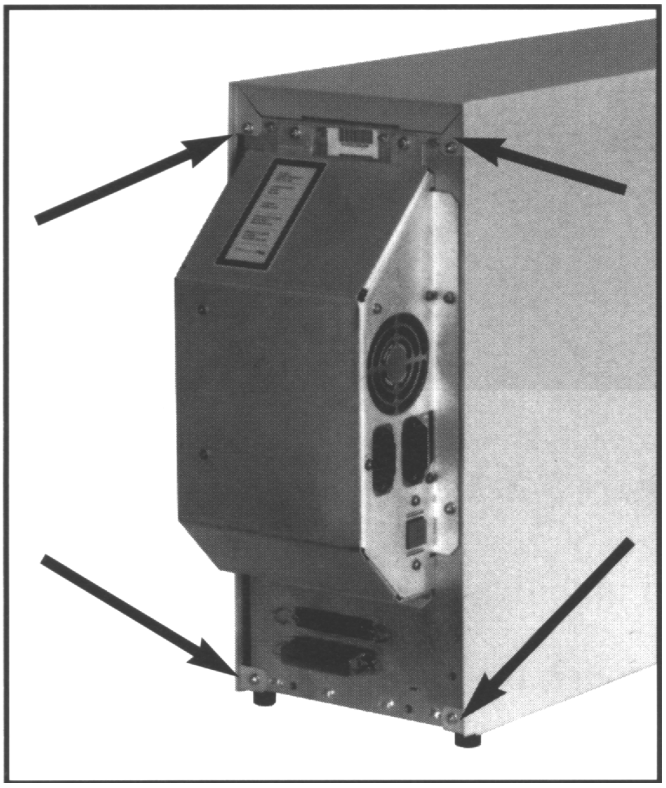
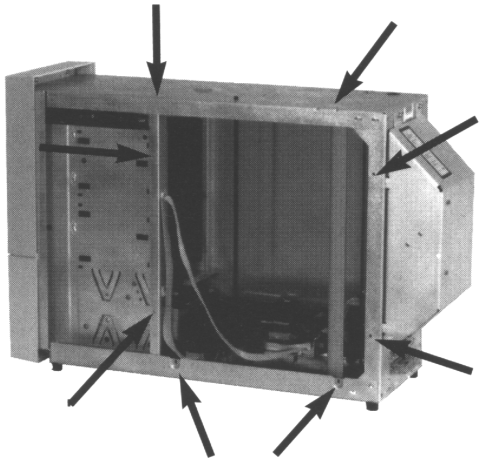
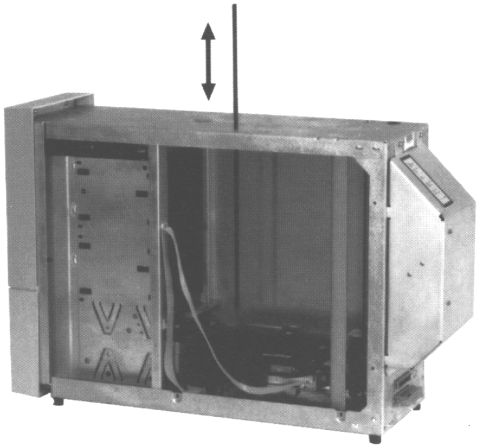


Figure 5–2 Removing the Access Panel



6. Remove the picker umbilical cable shield rod. Pull the rod out through the top of the chassis

Figure 5–3 Removing the Picker Umbilical Cable Shield Rod



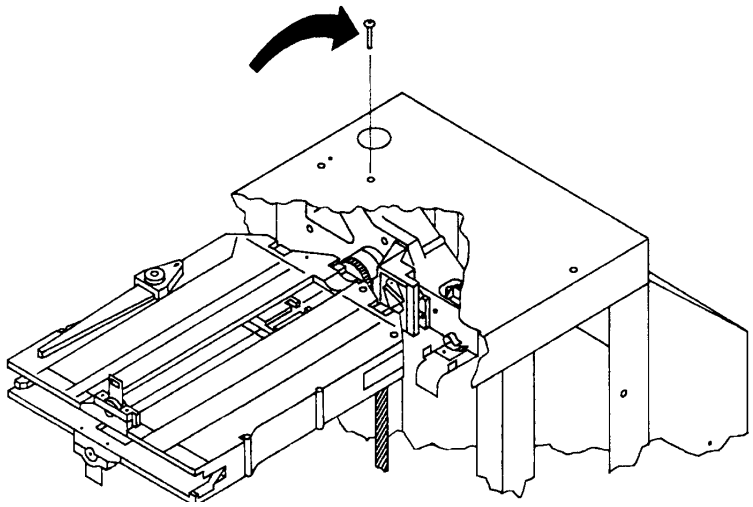
When re-assembling: The rod fits it into a hole at the bottom of the chassis. BE SURE THAT YOU PLACE THE PICKER UMBILICAL CABLE OUTSIDE THE ROD.

When replacing the access panel, MAKE SURE THAT THE COVER DOES NOT PINCH THE LARGE POWER CABLE ASSEMBLY that lays along the bottom of the chassis.

Replacing the Autochanger Controller PCA

1. Follow the steps in the service access procedure at the beginning of this chapter to remove the outside cover and side access panel.
2. Pull the picker up to the top of the chassis and insert a T-25 screw in the service hole, which holds the picker at the top of the chassis.

Figure 5–4 Fastening Picker to the Service Position



Unplug the following cables from the controller PCA (refer to Figure 5–5):

- SCSI cable
- Power cable
- Motor encoder and power cables
- Picker cable

NOTE

It is easier to remove the drive I/O and front panel cable if you remove the three T-15 mounting screws that hold the PCA to the bottom of the chassis. Pull the controller PCA out of the two tab holes that hold up the opposite side of the board. The board may then be pulled away from the drive enough to easily grip and remove the cable.

Figure 5–5 Controller PCA Cables

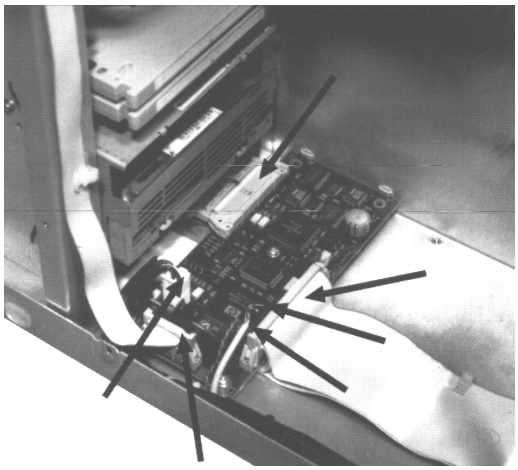
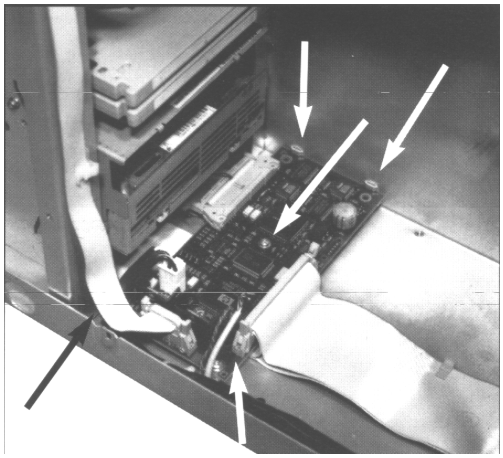


Figure 5–6 Controller PCA Mounting Screws and Tab Holes



After the controller PCA is loose (see the previous Note), disconnect the following:

- Drive I/O and front panel cable

3. Remove the controller PCA from the chassis.
4. Switch power on to the jukebox, and set configurations 16 and 18. (See "Setting a Configuration" in Chapter 3 and "Re-initializing the Autochanger Controller PCA RAM after Service" near the end of this chapter.)

Replacing Assemblies in the Front Bezel

NOTE

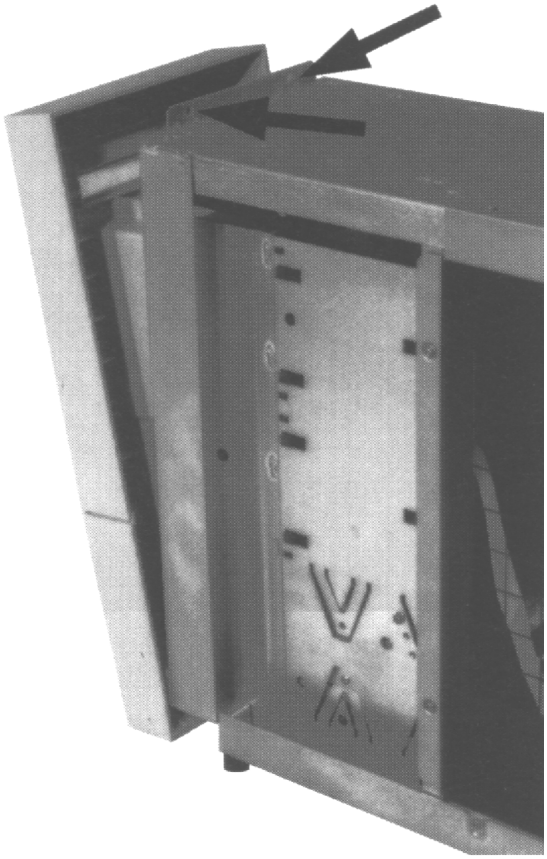
The front bezel must be removed in order to replace the following assemblies:

- cooling fan
- display assembly
- front panel cable
- mailslot

Accessing Components in the Front Bezel

1. Remove the outside cover as explained in the service access procedure at the beginning of this chapter.
2. Snap off the lower vent cover panel by either reaching under the bottom of the bezel and pulling up and out or by pulling on both lower sides of the vent cover with your fingertips. The cover will snap free.
3. Remove the two T-25 screws that secure the front bezel to the chassis. These screws are located behind the bezel as shown in Figure 5–7.

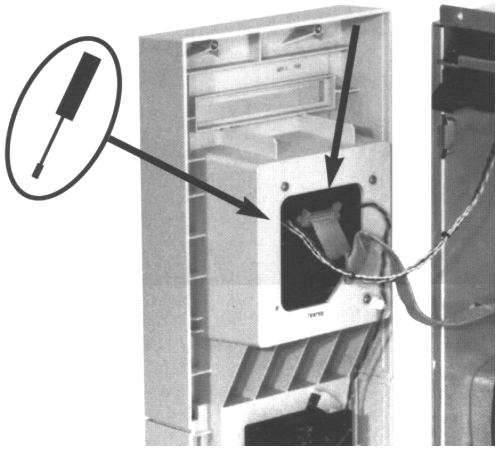
Figure 5–7 Front Bezel Mounting Screws



4. Rotate the front bezel out and disconnect the front panel cable and the mailslot sensor cable.

> **NOTE**
> A tab on the top of the mailslot sensor cable must be released before the cable can be unhooked. Insert a small screwdriver and push this tab down (see inset in Figure 5–8).

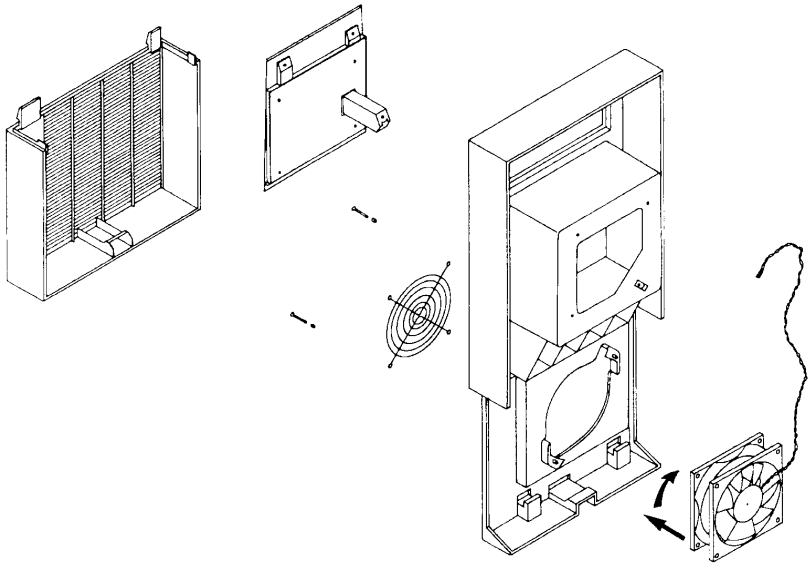
Figure 5–8 Front Panel Tilted Out



Replacing the Fan

1. Follow the steps in "Accessing Components in the Front Bezel" in the previous section.

Figure 5–9 Replacing the Fan



2. Remove the two T-15 screws that secure the fan grill to outside of the front bezel.
3. Turn the fan counterclockwise (looking from the back of the bezel) to release the two fan mounting tabs from the slots in the front bezel and remove the fan.

When Reassembling:

- Position the fan so that the cable faces toward the display assembly and the air-flow indicator faces up.
- The bend in the grill "feet" face toward the bezel.

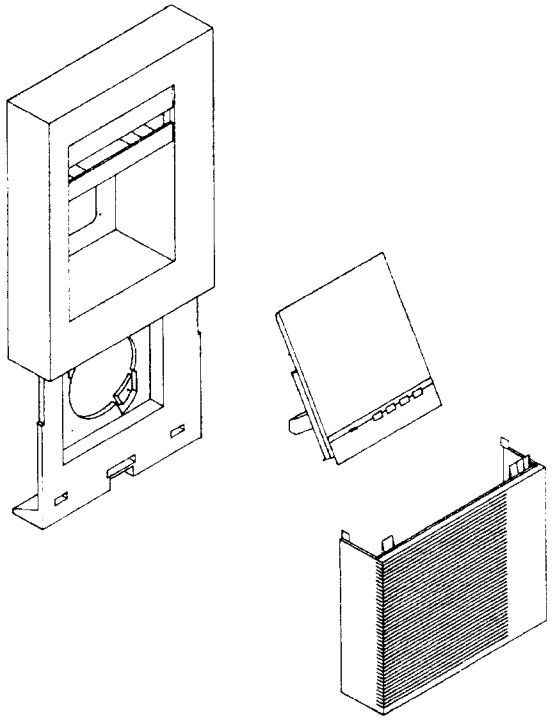
Replacing the Display

CAUTION

Hold your hand over the front of the display while removing the screws that secure it to the front bezel. The display assembly will fall out of the front bezel and could be damaged when these screws are removed.

1. Follow the steps in "Accessing Components in the Front Bezel" in the previous section to remove the front bezel.
2. Remove the three T-15 screws holding the display.

Figure 5–10 Replacing the Display



When Reassembling:

- Hold the display in place while re-attaching it to the front bezel to avoid damaging the display.

Replacing the Mailslot Assembly

1. Follow the steps in "Accessing Components in the Front Bezel" in the previous section.
2. Ensure that the mailslot sensor cable is disconnected.
3. Remove the two T-15 mailslot mounting screws from the upper left side of the chassis. These screws are recessed; use a T-15 driver with an extended shaft.
4. Remove the thumbscrew from the upper right side of the chassis (see Figure 5–12).
5. Slide the mailslot forward out of the autochanger.

Figure 5–11 Mailslot Mounting Screws

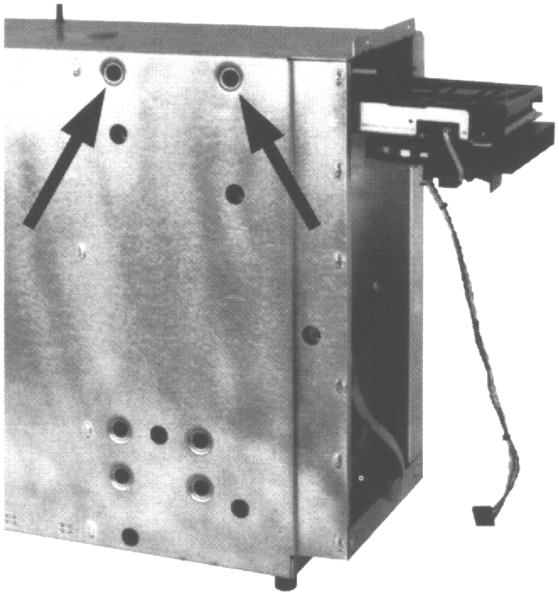
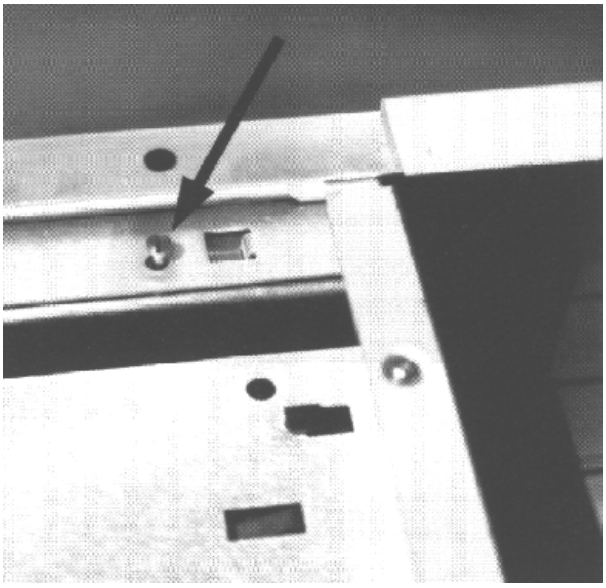


Figure 5–12 Mailslot Mounting Thumbscrew



When Reassembling:

- When re-inserting the mailslot into the chassis, lift up on the mailslot assembly from inside the chassis to ensure the mailslot is seated properly on the guides.

Replacing the Optical Drive Mechanism

> **NOTE**
>
> 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. Instructions for using the eject tool are given in the section, "Using the Eject Tool to Remove a Disk From the Drive" in Chapter 4.

The drive mechanism does not need to be removed to remove a disk from the drive

1. Follow the steps in the service access procedure at the beginning of this chapter to remove the outside cover and side access panel.
2. Follow the steps in "Accessing Components in the Front Bezel" in the previous section.
3. Remove the RFI shield.
4. Slide the picker up as far as it will go and secure it to the top of the chassis using a T-25 screw (see Figure 5–14).

Figure 5–13 Removing the RFI Shield

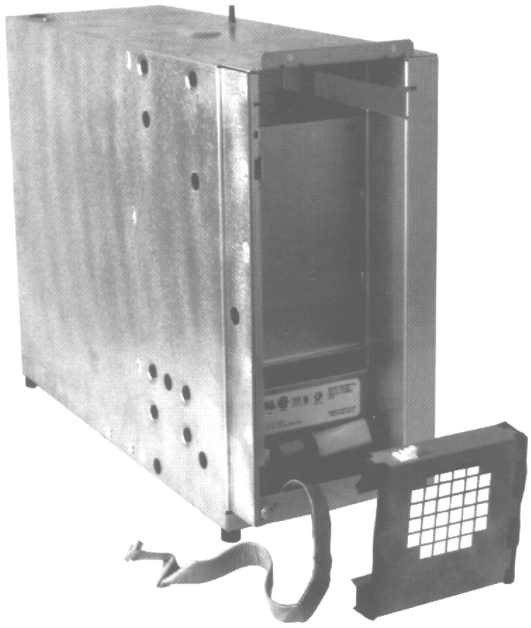
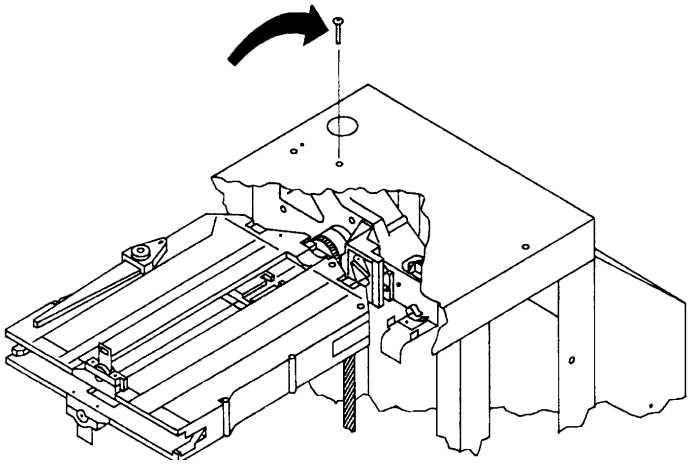


Figure 5–14 Fastening Picker to the Service Position



5. Remove the power cable, drive interface cable, and SCSI cable from the rear of the drive mechanism.

Figure 5–15 Drive Cable Connections – 1 drive version

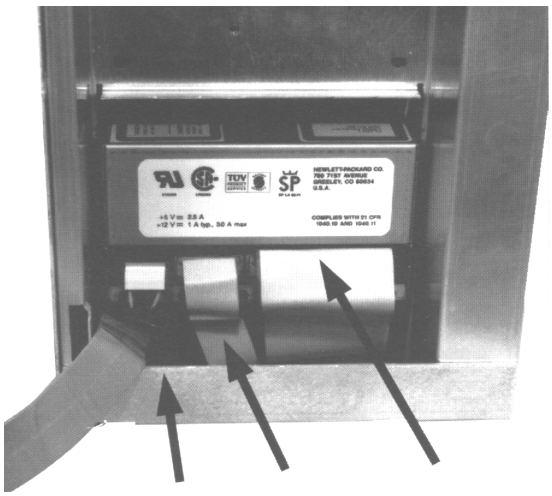
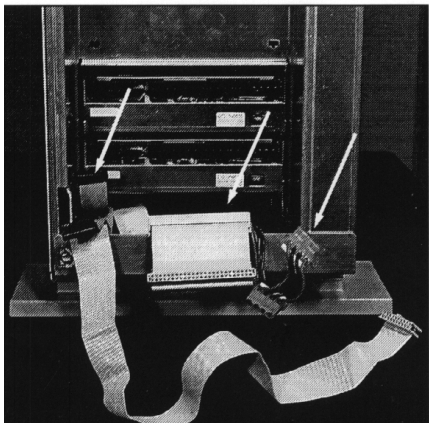
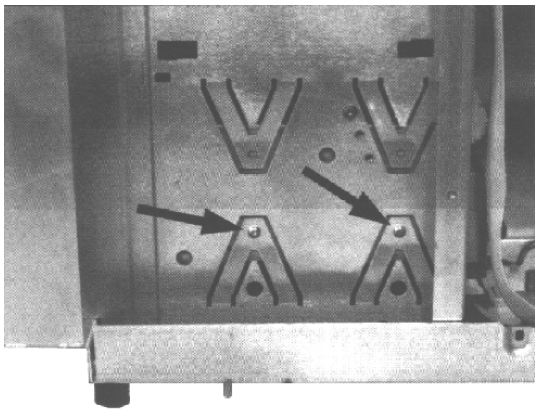


Figure 5–16 Drive Cable Connections – 2-drive (4X) version



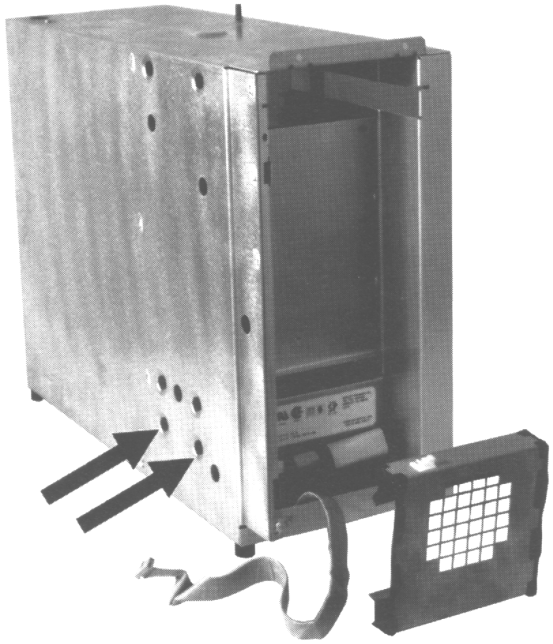
6. Remove the two T-10 screws that hold the side of the drive to the chassis on the side as shown in Figure 5-16.

Figure 5–17 Right-Side Drive Mounting Screws



7. Remove the two T-10 screws that hold the drive to the opposite side of the chassis as shown in Figure 5–17. The drive screws are in the lower set of holes. The Torx driver must have about a 4-inch shaft to reach the screws through the grommets.
8. Remove the drive.

Figure 5–18 Left-Side Drive Mounting Screws



When Reassembling:

- Verify that the drive contains the correct firmware revision

Manually Removing Disks From Drives

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 RWZ53 optical drive, you may order one of these:

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

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

Length: 50 mm

Width: 2.45 mm

Thickness: 0.5 mm

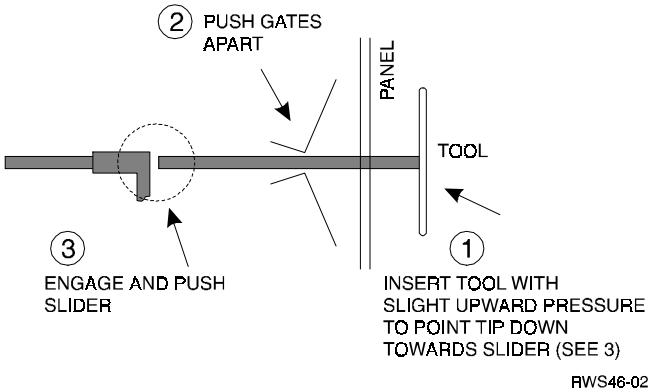
A disk can be removed from the drive while the drive is still secured in the autochanger. Follow the service access procedures which access the front of the drive mechanism, and then do the following steps to remove a disk from the drive:

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.
4. Engage the slider with the tip of the tool. The disk mechanism will eject the disk.

CAUTION

Wait until the disk ejects before removing it. Premature removal of the disk could damage the drive.

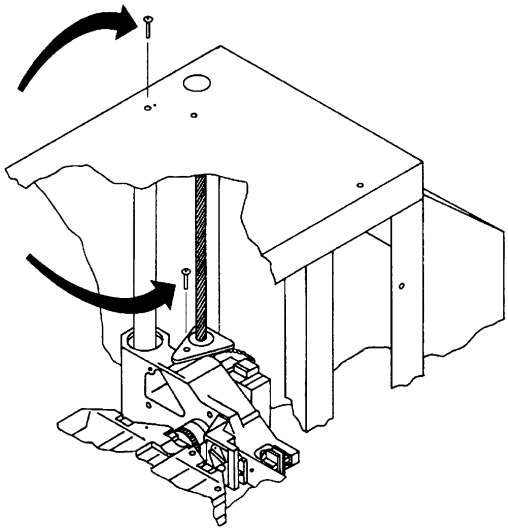
Figure 5–19 Inserting the C1113 Disk Eject Tool



Replacing the Picker/Carriage Assembly

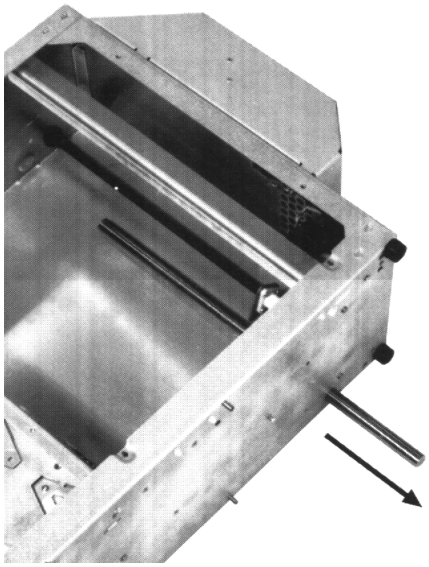
1. Follow the steps in the service access procedure at the beginning of this chapter to remove the outside cover and side access panel.
2. Lay the jukebox on its side.
3. Remove the T-15 screw that secures the carriage to the leadscrew assembly (the lower arrow in Figure 5-20). (This screw is sealed with Loctite®)
4. Disconnect the umbilical cable from the controller PCA.
5. Remove the T-25 screw that secures the carriage shaft to the top of the chassis (the upper arrow in Figure 5-20).

Figure 5–20 Dismounting the Carriage/Picker Assembly



6. Slide the carriage shaft out of the opening in the bottom of the chassis.

Figure 5–21 Removing the Carriage Shaft



7. Remove the picker assembly by lifting up on the side of the picker that was nearest to the carriage shaft, and then rotating the picker to a horizontal position. Carefully lift the picker assembly out of the chassis.

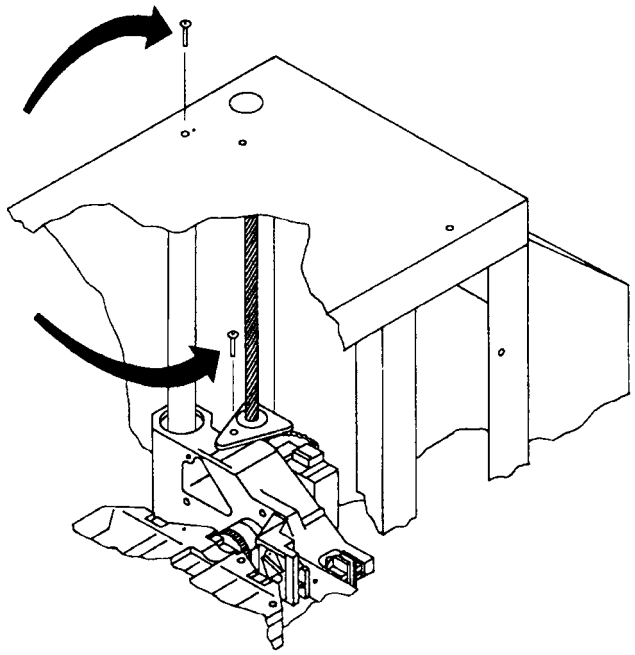
When Reassembling:

- Position the picker assembly in the autochanger before re-inserting the carriage shaft.
- The slotted end of the carriage shaft fits into a round metal protrusion at the top of the chassis.

Replacing the Leadscrew Assembly

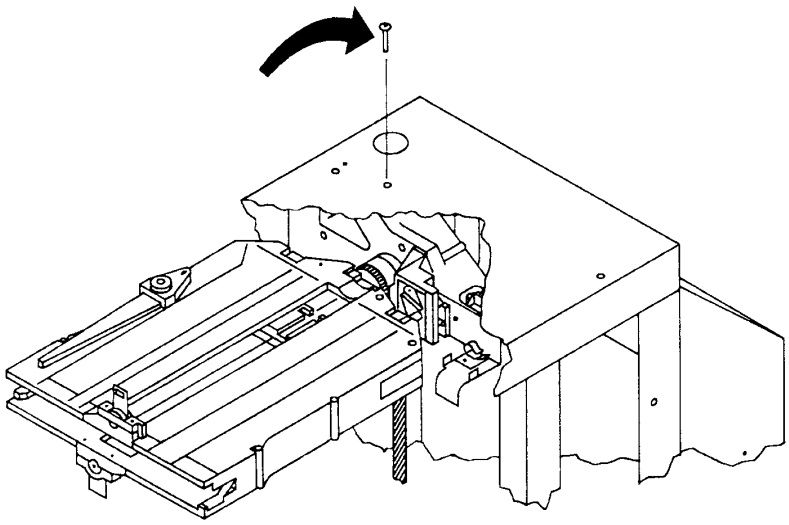
1. Follow the steps in the service access procedure at the beginning of this chapter to remove the outside cover and side access panel.
2. Remove the T-15 screw that secures the leadscrew assembly to the carriage/picker assembly (this screw is sealed with Loctite®).
3. Rotate the end of the bracket that was attached to the carriage picker assembly toward you, and slide the bracket up out of the way of the picker.

Figure 5–22 Removing the Leadscrew Mounting Screw



4. Slide the picker assembly up and secure it to the top of the autochanger using a T-25 screw (see Figure 5–23).

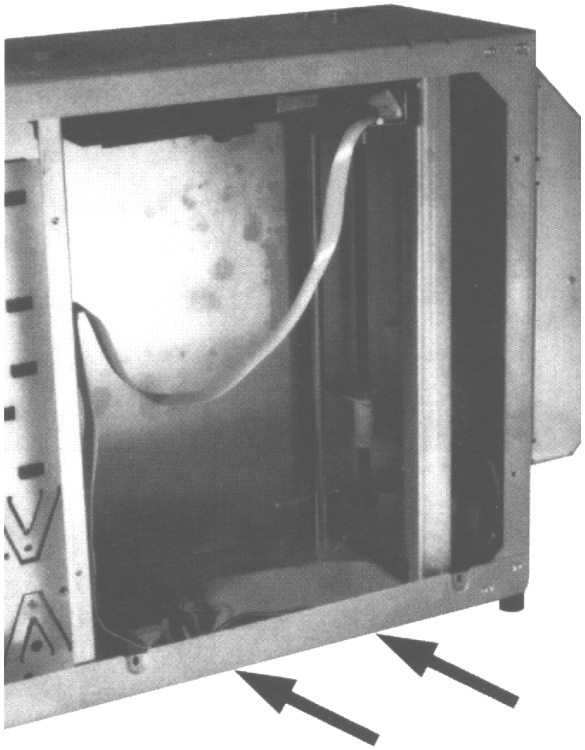
Figure 5–23 Fastening Picker to the Service Position



5. Disconnect the power and encoder cables from the controller PCA.
6. Squeeze the tip of the two cable clamps that protrude out from the bottom of the chassis (see Figure 5–24).

   This releases the clamp, allowing you to pull the clamp away from the large power cable bundle that runs along the bottom of the chassis. The leadscrew motor and encoder cables are bundled in this group and must be freed before the leadscrew assembly can be lifted out.

Figure 5–24 Loosening the Power Cable Clamps

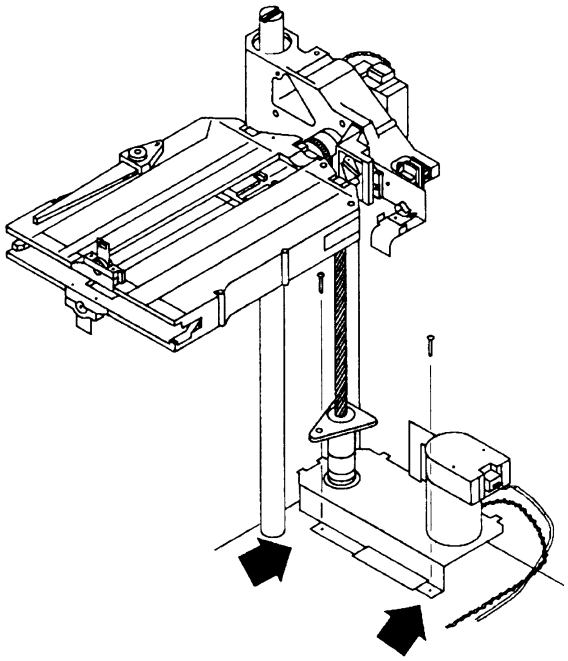


7. Remove the two T-15 screws that secure the leadscrew base to the bottom of the chassis (see Figure 5–25).

> **NOTE**
>
> Lift the leadscrew out carefully to prevent the bearings from falling off the top of the leadscrew.

8. Pull on the large tab on the leadscrew base to release the tabs that secure the base to the back of the chassis.
9. Rotate the motor end of the base in toward the center of the chassis and carefully lift the base out.

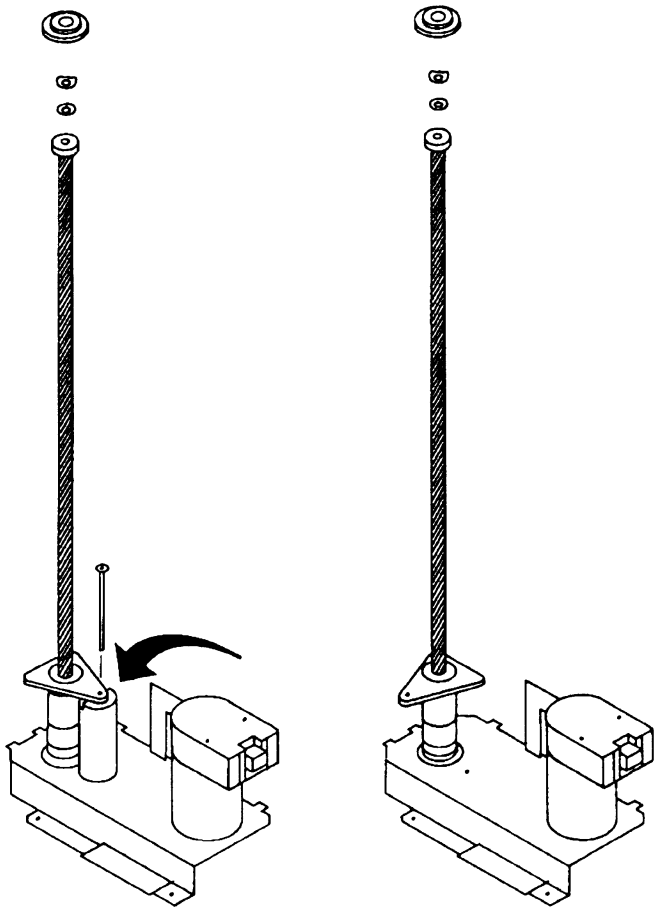
Figure 5–25 Removing the Leadscrew Assembly



When re-assembling:

- (Refer to Figure 5-26 when replacing the leadscrew assembly.)
- Verify that the bearings are positioned correctly at the top of the leadscrew.
- Align the tabs on the leadscrew base with the slots in the autochanger chassis and replace the two screws that secure the base to the chassis.
- Remember to remove the metal shipping bracket on the new leadscrew assembly.

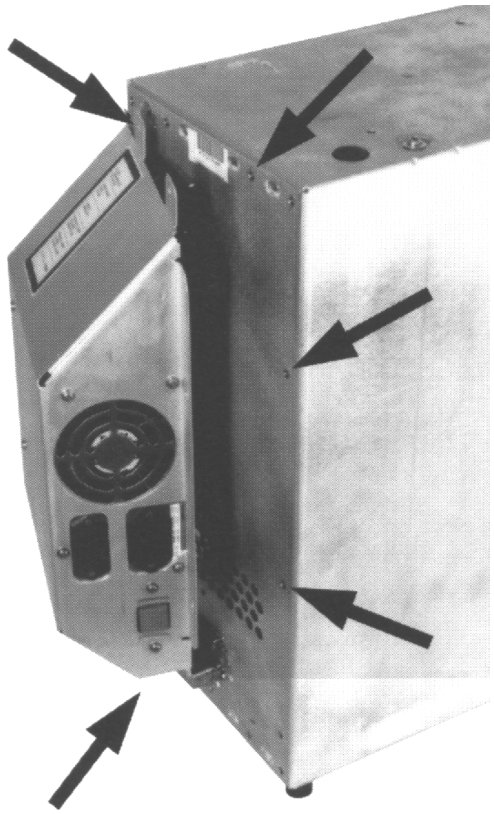
Figure 5–26 Preparing the Leadscrew Assembly for Replacement



Replacing the Power Supply

1. Switch off the power switch on the power supply module on the rear of the chassis.
2. Unplug the power cord from the power module.
3. Remove the T-25 screws that secure the power supply assembly to the back panel. The supply with the single-ended SCSI interface has five screws and the supply with the differential SCSI interface has seven screws.
   (Figure 5–27 shows the location of the screws on the single-ended interface).
4. The power supply is hinged on the left side (when facing the rear of the chassis). Open the right side of the power supply far enough to disconnect the power cable.

Figure 5–27 Power Supply Removal (Single-ended module shown)



NOTE

If the jukebox interface is differential SCSI, the SCSI interconnect cable (differential PCA-to-chassis rear panel) must also be disconnected before the power supply module is pulled away.

5. Remove the power supply assembly by lifting the supply up and away (there are tabs on the left edge of the supply).

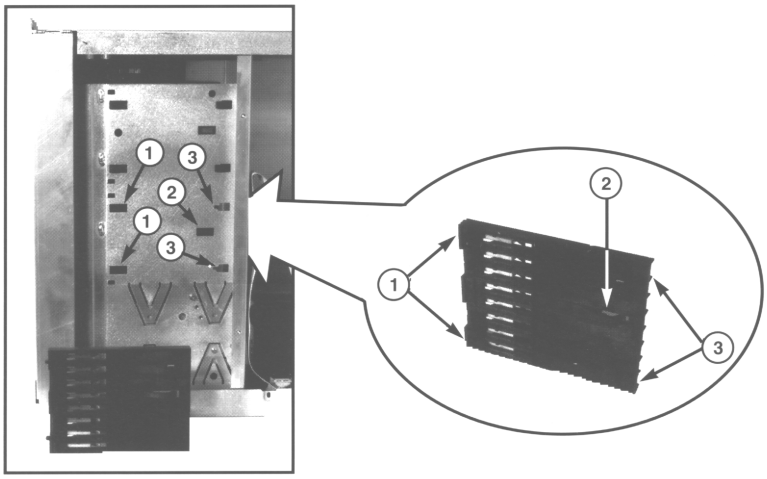
NOTE

No further disassembly of the power supply is required. The power supply assembly is replaced as an entire unit.

Replacing the Magazine Guides

1. If the magazine guides are not exposed, follow the steps in the service access procedure at the beginning of this chapter to remove the outside cover and side access panel.
2. Push the catch (#2 on Figure 5-28) on the side of the magazine to release the magazine's lock on the side of the chassis.
3. Pull back and inwards on the magazine to pull the four tabs out of their slots in the chassis (#1 and #3 in Figure 5-28).

Figure 5-28 Removing the Magazine Guides



When Reassembling:

Place the magazine so that its tabs (#1 and #3) go into the slots in the chassis. Slide the magazine in and forward until the snap lock (#2) slips into its slot.

Replacing the SCSI cable

NOTE

Assemblies that must be removed prior to replacing the SCSI cable are:

- the leadscrew assembly
- the autochanger controller PCA
- the front bezel; must be removed to access the rear of the drives to disconnect the cables

Replacing the Differential PCA (Differential Versions Only)

NOTE

The differential SCSI interface is part of the power supply field-replaceable unit and is not replaced by itself. Refer to “Removing the Power Supply” in this chapter.

Re-initializing the Autocharger Controller PCA RAM after Service

All the RAM on the auto charger controller PCA is kept alive through a charged capacitor, and is, therefore, relatively non-volatile, If this RAM is backed up to flash EEPROM after any changes, the values are held permanently. If not backed up to flash EEPROM, information bleeds off in approximately 10 to 60 days.

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 updating or changing the autochanger controller PCA firmware, and after replacing the drive mechanism.

Variables Set by Configuration 16

- SCSI address of the autochanger
- Configurable options set to system defaults (ROM-dependent)

  - whether the autochanger should report recovered errors (CONF27)
  - whether the autochanger should rotate the mailslot inwards when in secure mode (CONF31)
  - 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 the system defaults
  - clear the source of the disk in the drive
- Power fail variables
  - whether the last move that was started is set to FALSE
  - clear 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
  - clear unit reserve
  - clear Prevent Media Removal for each SCSI ID
- Element Status variables
  - clear exception bits
  - clear element reservations
- Clear autochanger logs
  - clear Error Log (INFO 0)
  - clear Move Success Log (INFO 10)
  - clear Recovery Log

- clear Runtime Log (INFO 11)
- clear number of major retries
- clear number of inline retries

Reset the password to 0 0 0

Variables Set by Configuration 18

- Reset the move odometer to zero (INFO 9)
- Reset the flip odometer to zero (INFO 12)
- Reset the translate odometer to zero (INFO 13)
- Reset the mailslot rotation odometer to zero (INFO 14)
- Reset the number of poweron hours to zero (INFO 5)

Reset the number of loads to each drive to zero (INFO 4)

Table 5–1 Non-Exchange Assemblies (See Figure 5–29)

FRU No.	Part Number	Description	Used by:
1	C1100-60x03	Autochanger controller PCA	SCSI
22	C1100-60x77	Front panel assembly	SCSI
26	C1100-60x26	Magazine guides (2)	SCSI
28	C1100-60x28	Power supply - single-ended SCSI interface	SCSI
28	C1100-60x30	Power supply - differential SCSI interface	SCSI
29	C1100-60x29	Mailslot assembly	SCSI
32	C1100-60x32	Leadscrew assembly	SCSI
40	C1100-60x40	Carriage/picker assembly	SCSI
41	C1100-60x41	Carriage/picker umbilical cable	SCSI
42	C1100-60x42	Carriage primary guide	SCSI
48	C1100-60x48	Fan assembly	SCSI
51	C1100-60x51	Power distribution cable	SCSI
52	C1102-60x51	Power harness cable	SCSI
52	C1100-60x51	Power cable (4X-drive jukeboxes only)	SCSI
60	C1102-60x55	Hard disk cable	SCSI
61	C1102-60x61	RJ-45 LAN cable	SCSI
63	C1102-60x63	AUI LAN cable	SCSI
65	C1100-60x65	Optical drive I/O and front panel cable (2X-drive jukeboxes only)	SCSI
65	C1100-60x52	Front panel cable (4X-drive jukeboxes only)	SCSI
69	C1100-60x59	Internal SCSI cable	SCSI
75	C1100-60x75	RFI shield	SCSI
75	C1100-60076	RFI shield (4X-versions only)	SCSI
78	C1708-60x78	Vent cover	SCSI
79	C1100-60x79	Front bezel assembly	SCSI
83	C1100-60x87	Carriage umbilical cable shield rod	SCSI
84	C1100-60x84	Enclosure, gray	SCSI
84	C1103-60x84	Enclosure, white	SCSI

NOTE

See note on page 5–37 for a description of part numbering.

Figure 5-29 RW546 Exploded View (1 of 3)

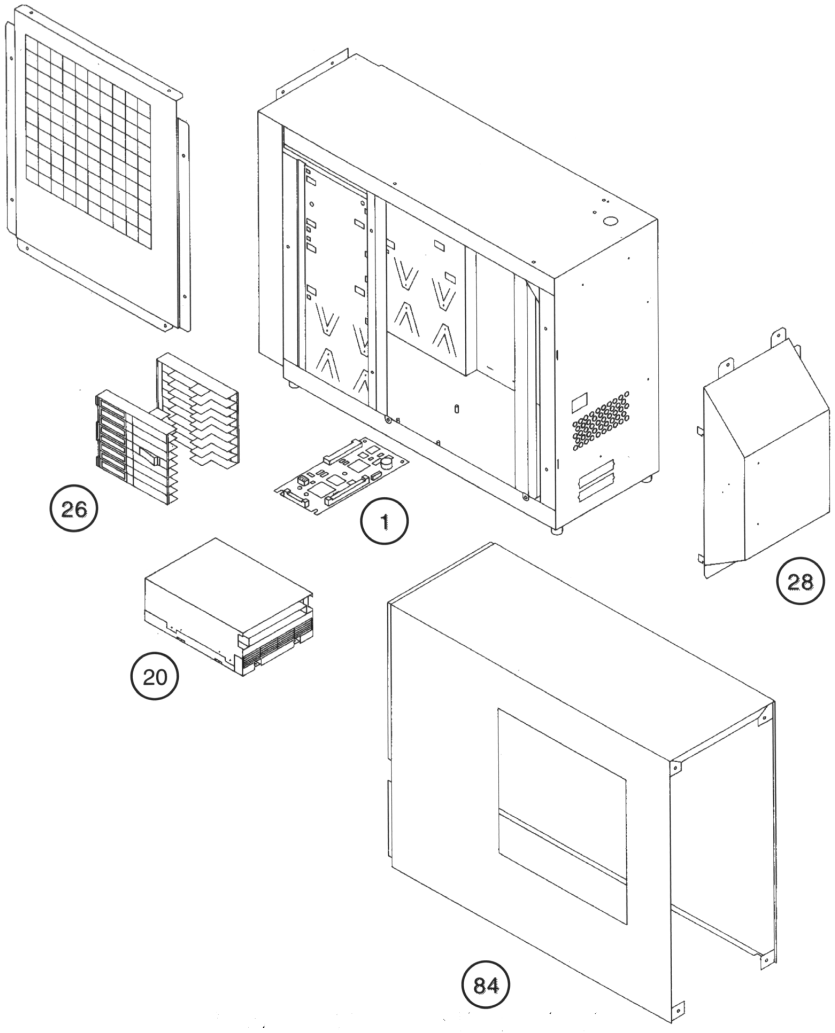


Figure 5-29 RW546 Exploded View (2 of 3)

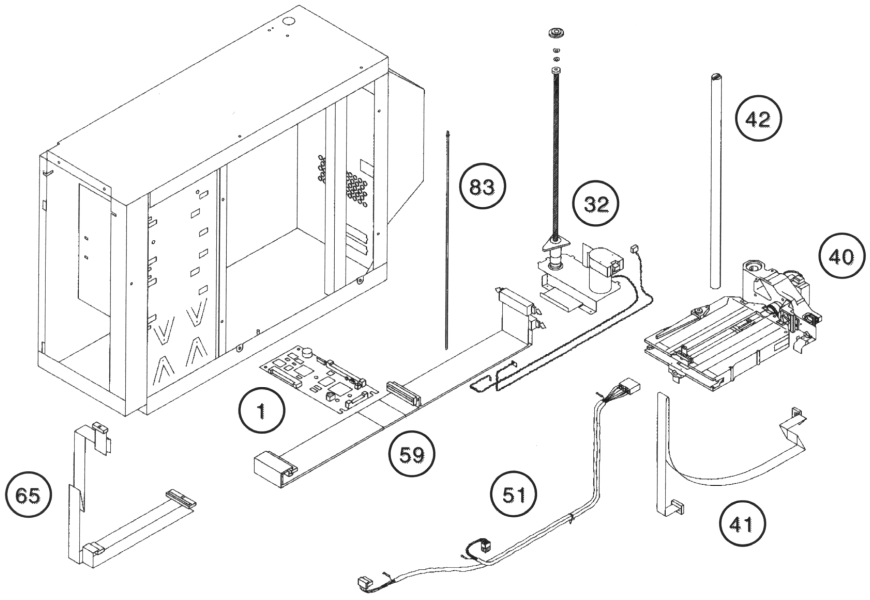
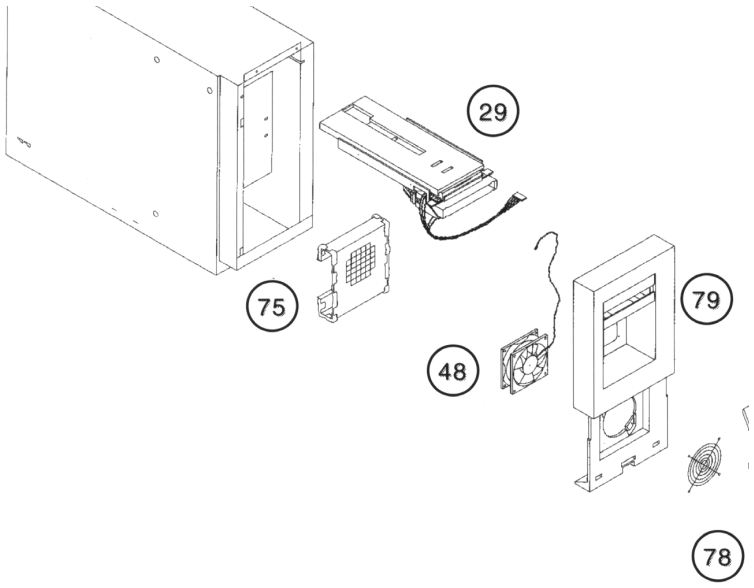


Figure 5-29 RW546 Exploded View (3 of 3)



Field Replaceable Units (FRU) in the (*Small*) Library

Table 5–2 is a list of FRU's in the Small Optical Disk Library RW546. The information includes a cross-reference between Digital and vendor part numbers, a description of the unit, the standard cost in US $, the Mean Time Between Failures for the assembly in hours (x 1000), and the repair cost in US $.

Table 5–2 List of Field Replaceable Units

Digital P/N	Vendor P/N	Description	Uniq Y/N	R&R Y/N	Std. US$	MTBFK Hrs	Repair Cost US$
RWZ53-AA	C1113-Opt 728	4x MO Drive	N	Y	1516.00	80	N/A
RWZ53-AA	5063-xxxx	4x MO Rep. Drive	N	Y	N/A	80	942.50
29-33441-01	5063-2783	Ctlr. PWA	Y	Y	208.50	150	*
29-32519-01	C1100-60028	Pwr. Supply Assy SE	N	Y	188.50	150	*
29-32520-01	C1100-60030	Pwr. Supply Assy Diff	N	Y	438.75	150	*
29-32521-01	C1100-60040	Carriage/Picker Assy	N	Y	373.75	150	*
29-32528-01	C1100-60077	Front Panel Assy	N	Y	117.00	250	*
29-33416-01	C1100-60229	Mailslot Assy	N	Y	130.00	250	*
29-32534-01	C1100-6006-32	Lead Screw Assy	N	Y	221.00	250	*
29-32522-01	C1100-60041	Umbilical Cable	N	N	14.62	999	N/R
29-32524-01	C1100-60048	Fan Assy	N	N	26.65	999	N/R
29-33438-01	C1100-60159	SCSI I/O Assy	Y	N	40.62	999	N/R
29-33439-01	C1100-60162	F. Panel Assy	Y	N	14.30	999	N/R
29-33435-01	C1100-60151	Power Cable	Y	N	35.75	999	N/R
29-32518-01	C1100-60026	Mag. Guides	N	N	68.25	999	N/R
29-32523-01	C1100-60042	Primary Guide	N	N	50.38	999	N/R
29-33440-01	C1100-60076	RFI Shield	Y	N	27.50	999	N/R
29-32529-01	C1100-60079	Bezel Assy	N	N	40.62	999	N/R
29-32530-01	C1100-60087	Umb. Shield	N	N	10.40	999	N/R
29-32532-01	C1100-60084	Enclosure	N	N	143.00	999	N/R
29-33437-01	1252-4366	50 pin DIP term	Y	N	40.63	999	N/R

* Reflects parts under one-year warranty from Hewlett Packard.

Recommended Service Kits

The initial recommended service for the optical jukebox includes the exchange parts list and the non-exchange parts list for stocking at a field-level office.

NOTE

The "x" in the part numbers listed in the following parts tables represents a number from "0" to "9" depending 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 increments to "1"; the second time the part is revised, the number increments to "2", and so on. If you are unsure of the current part number, enter a "0" or a "1" in place of the "x" when checking your parts database and the current part number will be displayed.

Table 5–3 Exchange Parts

FRU No.	Part Number	Description	Version
20	C1716-69x02	2X optical drive mechanism	SCSI
20	C1113-69x00	4X optical drive mechanism (4X-drive jukeboxes only)	SCSI

Miscellaneous

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

Table 5–4 Common Resource Parts

Item	HP Part Number
0.5 m (1.6 ft.) SCSI peripheral interface cable	92222A
1 m (3.3 ft.) SCSI peripheral interface cable	92222B
2 m (6.6 ft.) SCSI peripheral interface cable	92222C
1 m (3.3 ft.) SCSI extender cable	92222D
Single-ended SCSI terminator, 50-pin	1252-3920
Differential SCSI terminator, 50-pin	1252-4447
Eject tool (C1716T)	C1701-88803
Optical disk media cleaning kit	C1700-88800
Optical disk cleaner accessory kit (extra swabs and alcohol)	C1700-88801

6

Theory of Operation

This chapter describes how the hardware and software work together in the library to produce the robotics of the RW546.

This chapter discusses the following aspects of the robotics of the RW546 optical disk jukebox.

- the autochanger
- command execution
- mechanics
- autochanger controller PCA
- power supply
- optical disk drive
- autochanger error detection
- diagnostic strategy
- SCSI interface command set

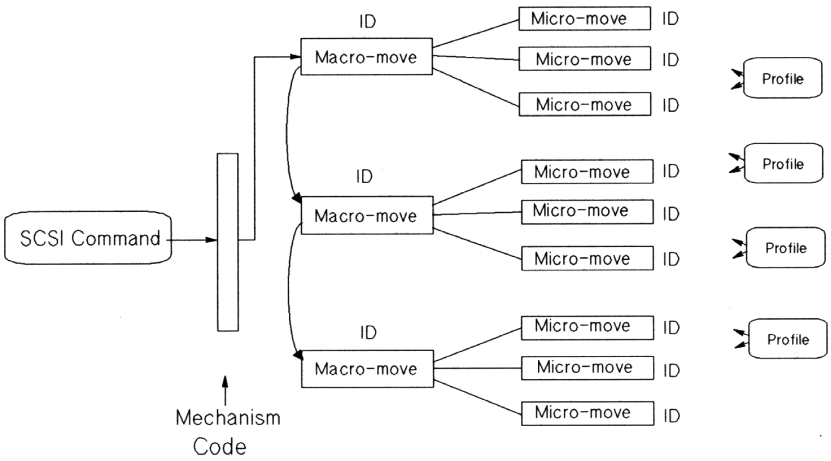
The Autochanger

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 jukebox 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 a high force is expected within a given distance; however, 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.

Mechanics

The mechanics consist of the following major assemblies:

- leadscrew assembly
- picker/carriage assembly
- mailslot (disk loading and ejecting assembly)

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

The carriage/picker assembly includes active payload electronics that are similar in design to a plotter's. A single-axis plunge is used since the picker does not need to travel horizontally (translate). The picker electronics include the picker motor with a ribbon cable connecting the motor to the carriage and the autochanger controller PCA.
The disk insertion slot, referred to as the mailslot, accepts a disk (inserted shuttour-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-first into the drive or a storage slot.

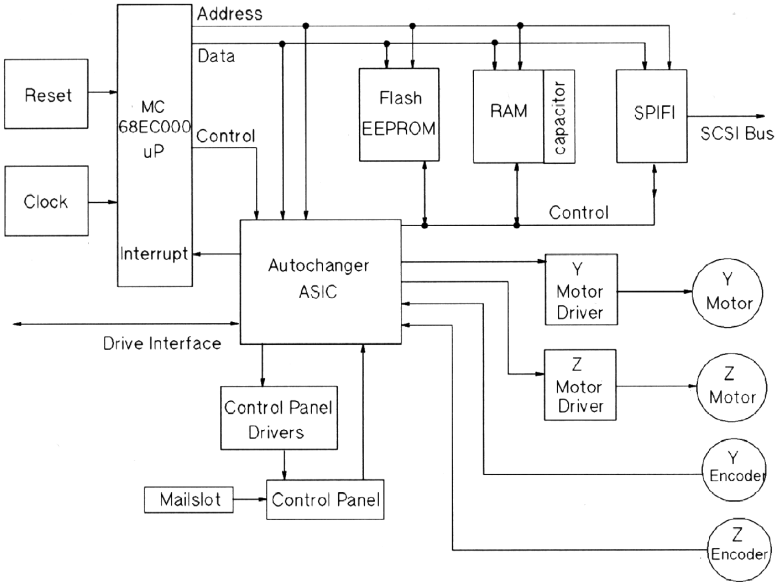
The carriage motor rotates the carriage leadscrew, driving the carriage. The motor also monitors the amount of movement with a built-in encoder wheel.

The Autochanger Controller PCA

The autochanger controller PCA contains the following major components:

- microprocessor
- autochanger ASIC
- SPIFI Chip (SCSI bus control)
- flash EEPROM
- RAM
- front panel control and filament drive
- SCSI interface

Figure 6–2 Autochanger Controller PCA Block Diagram



The MICROPROCESSOR is a Motorola MC68EC000 running at 12.288 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, RAM with standby power supplied by a capacitor, and ROM.

The AUTOCHANGER APPLICATION-SPECIFIC INTEGRATED CIRCUIT (ASIC) provides an interface to the processor interface, programmable features, and a servo system.

The processor interface functions are: decoding the processor's address space, and generating select and strobe signals to give the processor access to the flash EEPROM, RAM, optional PSRAM, the SCSI controller, internal registers, I/O ports, and optional external registers. Also, the processor interface function of the chip includes the handling of internally- and externally-generated interrupt sources.
The programmable features section of the chip provides a control panel display state machine and firmware-configurable feature and general-purpose ports.

The servo system section of the chip provides servo timers, three motor control pulse-width modulators, and three quadrature encoder channels.

Drive interface signals EJECT and BUSY are also handled by this chip.

The ASIC is also the interface between the processor and the motors. The ASIC reads the position encoders and uses that information to increment or decrement counters on the chip. The ASIC also provides pulse width modulation (PWM) output signals to drive the motor circuitry.

All SCSI protocol is handled by the SPIFI chip under control of the MC68EC000 processor and the Autochanger ASIC chip.

FLASH EEPROM. The controller firmware resides in two flash EEPROMs. These flash EEPROMs allow new firmware versions to be downloaded to the controller in the field.

RAM. The two RAM chips are special, low-power CMOS static RAMs. A standby capacitor on the PCA takes over powering these chips if main power is lost. The chips remain in standby mode (from about 10 to 60 days), providing a non-volatile memory storage capability when the unit is powered off.

The Y and Z MOTOR CONTROL DRIVERS take the pulse-width modulated signals from the motor control chip and change them into positive- and negative going pulses for the picker motor and carriage motor. Motor speed control is by feedback from the picker and carriage motors through the Y and Z ENCODERS.

The CONTROL PANEL DRIVERS generate a vacuum filament display using a 7.5-volt supply tied to a 5-volt reference, which results in an excitation voltage of from two to three volts. The grids of the display are at approximately 20 volts. Buffers for incoming control panel switch signals and signals from the mailslot sensor are also handled by the control panel drivers.

The Power Supply

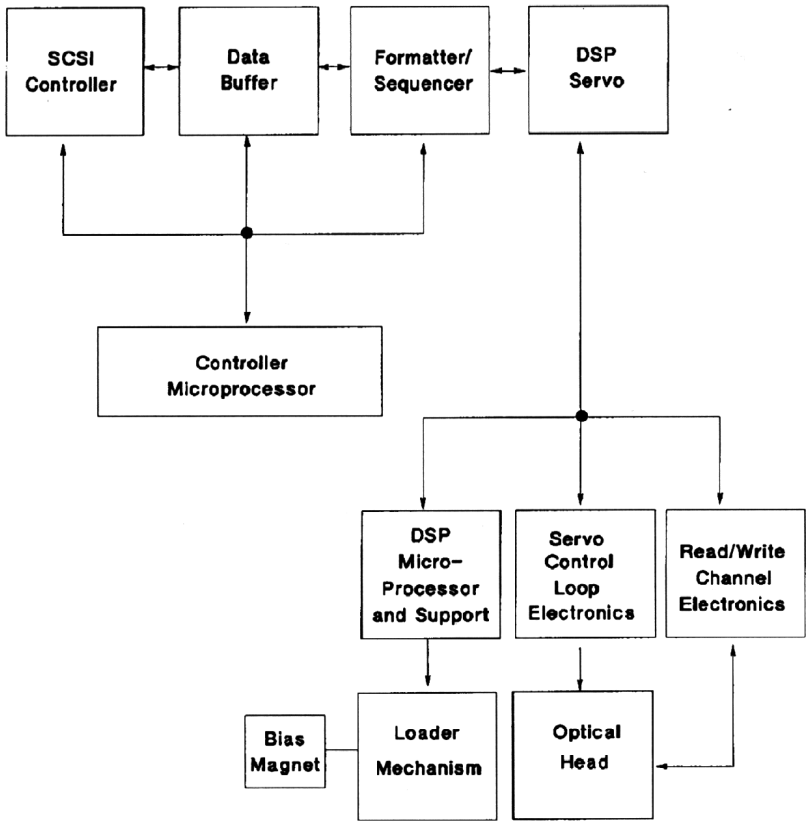
The power supply is an autoranging supply that provides +5V at 22 amperes, +12V at 8 amperes, -5V at 0.5 ampere, and -12V at 0.5 ampere. The maximum continuous output power is 200W.

AC line voltage is connected to the power supply through a line cord receptacle mounted on the power supply PCA. The ON/OFF switch controls both sides of the AC line. An input line filter is provided to reduce the level of AC line transients and the amount of switching noise leaving the supply.

An over-voltage protection device protects the supply from input over 240 volts.

The Multifunction Optical Drive and Drive Controller

Figure 6–3 Functional Diagram



There are four major sub-assemblies within the optical drive:

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.

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.

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 Digital RWZ52 drive contains 512 Kbytes of buffer RAM.

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. The formatter converts the 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.

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.

DSP Microprocessor and Support/Servo Control Loops

Most of the electronics on the servo PCA is 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 control panel LEDs, and control circuitry for the bias magnet subassembly of the loader mechanism.

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.

Mechanism Assembly

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.

Optical Head

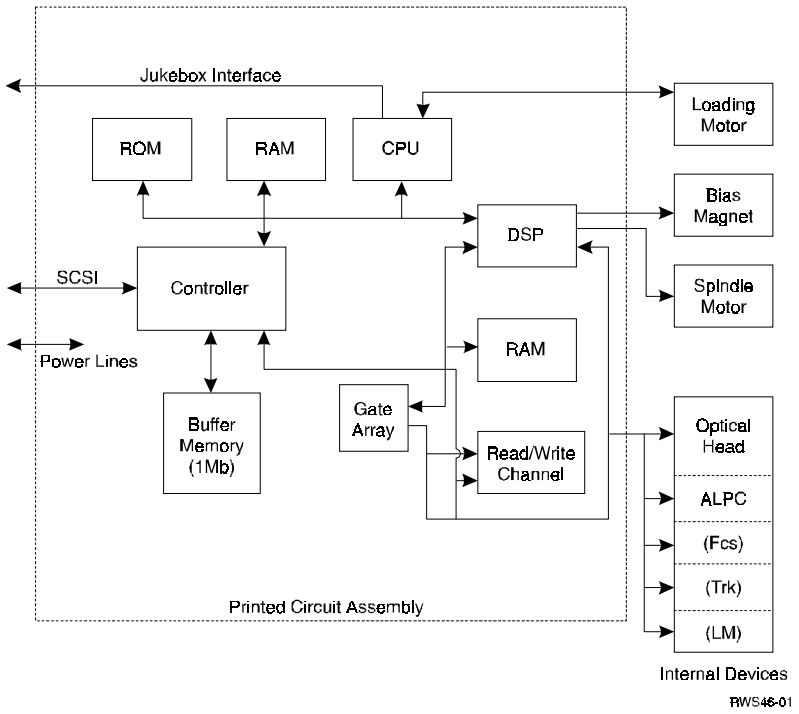
A major feature of the optical head is a "split optics" design. This design physically separates the laser diode and its associated detectors from the focus/fine position actuators. This design results in a significant seek time performance advantage due to less mass on the moving portion of the optical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

4X Drive Mechanism

Figure 6–4 4X Drive Functional Diagram



Controller

The controller is a highly-specialized integrated circuit that handles SCSI control, data buffering, and encode/decode.

The data buffer function provides 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 C1113 uses a 1-megabyte buffer memory.

This 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.

The encode/decode function encodes and decodes data for read and write transfers. During a write function, user data is sent via the SCSI bus. The encoder converts the 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.

CPU

The central processing unit for all drive functions including the loading motor.

Gate Array

This component contains circuitry to interconnect the major blocks (CPU, DSP, write/read channel).

DSP (Digital Signal Processor)

The DSP controls 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.

Read/Write Channel Electronics

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

Loading Motor

The loading motor loads and unloads the optical disk 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.

Bias Magnet

The bias magnet subassembly sits on top of the cartridge shuttle and provides the correct polarity for erasing or writing data.

Optical Head

The optical head assembly contains both mechanical and electronic components and is a "split optics" design.

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

The actuators and laser diode (and associated detectors) are on a small PCA on the optical head assembly. The main components are as follows:

Auto Laser Power Control (ALPC)

Controls the intensity and duration of the laser beam for erase, write and read operations.

Focus Servo (Fcs)

Controls the vertical motion of the objective lens to focus the laser beam on the disk surface.

Fine Tracking Servo (Trk)

Controls the horizontal motion of the objective lens to follow the track of the disk.

Linear Motor (LM)

Positions the actuator in the vicinity of the desired track on the disk.

Optical Disk Layout and Error Correction

Disk Formats

Two optical disk formats are available. The Digital RWZ53 optical drive can read from and write to both and 1.3 and 2.6-Gbyte optical disks; it can also read 650-Mbyte disks.

NOTE

The 650 Mbyte optical disk is read-compatible only.

The target's role is to manage the 130 mm multifunctional drive and disk as an optical memory device through its SCSI interface. These optical drive supports 130 mm 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 and the drive also supports the ECMA 184 standard for 1.3-Gbyte capacity, both rewritable and write-once.

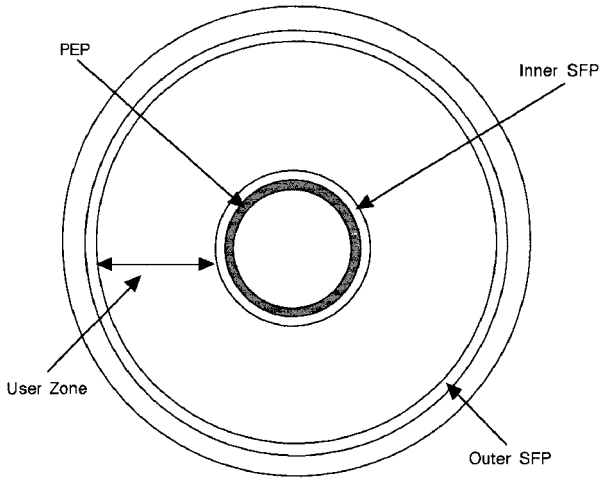
The following sections outline disk layout for the 650-Mbyte and 1.3 and 2.6-Gbyte optical disks. Throughout this section, the sector number is that of a 1,024 bytes/sector disk. The value of a 512 bytes/sector disk is written inside parentheses just after the value for the 1,024 bytes/sector disk.

Optical Disk Layout

This section highlights some of the aspects of 650-Mbyte capacity optical disks as outlined by ISO/IEC 10089A and ISO/IEC DIS 11560.

The disk is divided into various zones. 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 and write to the optical disk. Consult the ISO standard for more information.

Figure 6–5 Optical Disk Layout



User Zone Layout

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 6–5 shows the following parts of the User Zone for 650-Mbyte 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

650-Mbyte Disk User and Spare Groups

Figure 6–6 shows the User Zone Layout for 650-Mbyte disks. The values for g, m, and n are variable depending on how the disk is formatted.

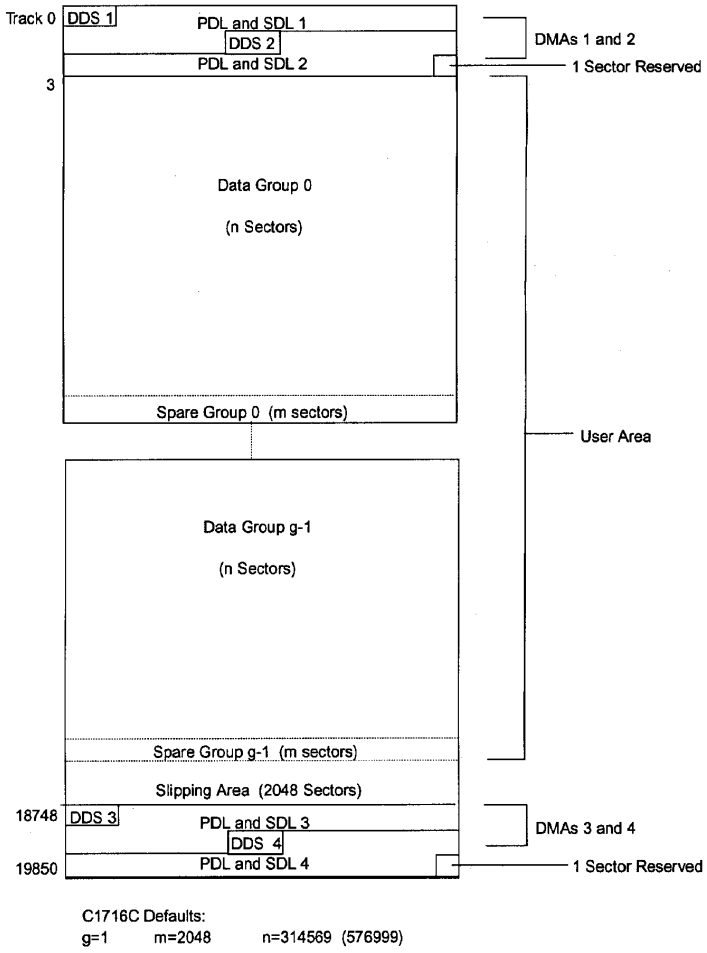
1.3-Gbyte Disk User and Spare Groups

Figure 6–7 and Figure 6-8 show the User Zone Layout for 1.3-Gbyte, for both g=1 (single data area and one spare area) and g=16 (16 data areas and 16 spare areas), 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. The 1.3-Gbyte media establishes groups BEFORE accounting for slip spares. (Please refer to the section on Drive Defect Management for more details.)

2.6-Gbyte Disk User and Spare Groups

There are 34 User/ Spare groups for 1,024 bytes/sector media and 30 groups for 512 bytes/sector media. The 2.6-Gbyte media establishes groups BEFORE accounting for slip spares. (Refer to the following section, "Drive Defect Management" for more details.)

Figure 6–6 User Zone Layout for 650-Mbyte Media



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 6–5. 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.

User Zone Layout - 1.3-Gbyte Capacity

The User Zone consists of Defect Management Areas (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 6-7 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

NOTE: g = 1 or 16

Figures 6–7 and 6–8 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 the section on Drive Defect Management for more details.)

Figure 6–7 User Zone Layout for 1.3-Gbyte Media, g=1

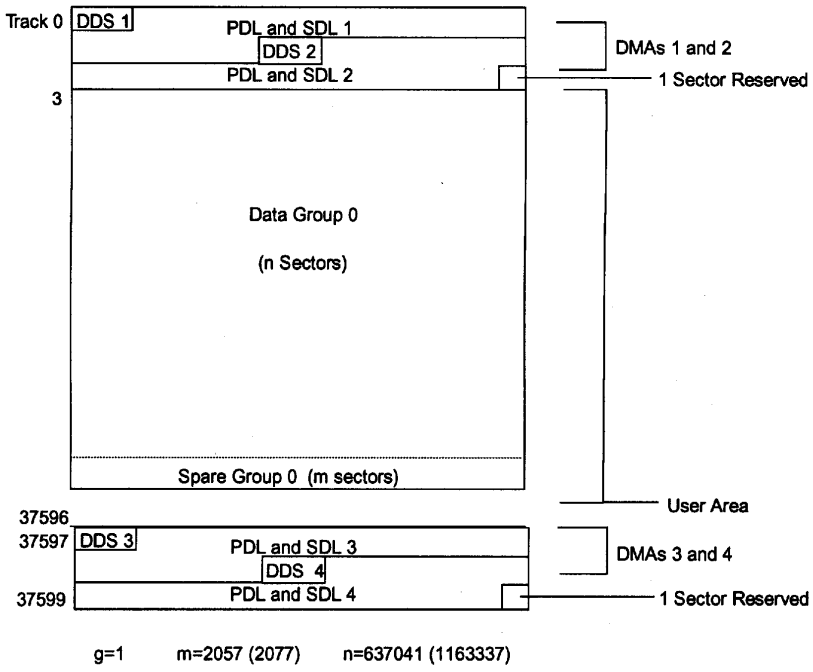


Figure 6–8 User Zone Layout for 1.3-Gbyte, g=16

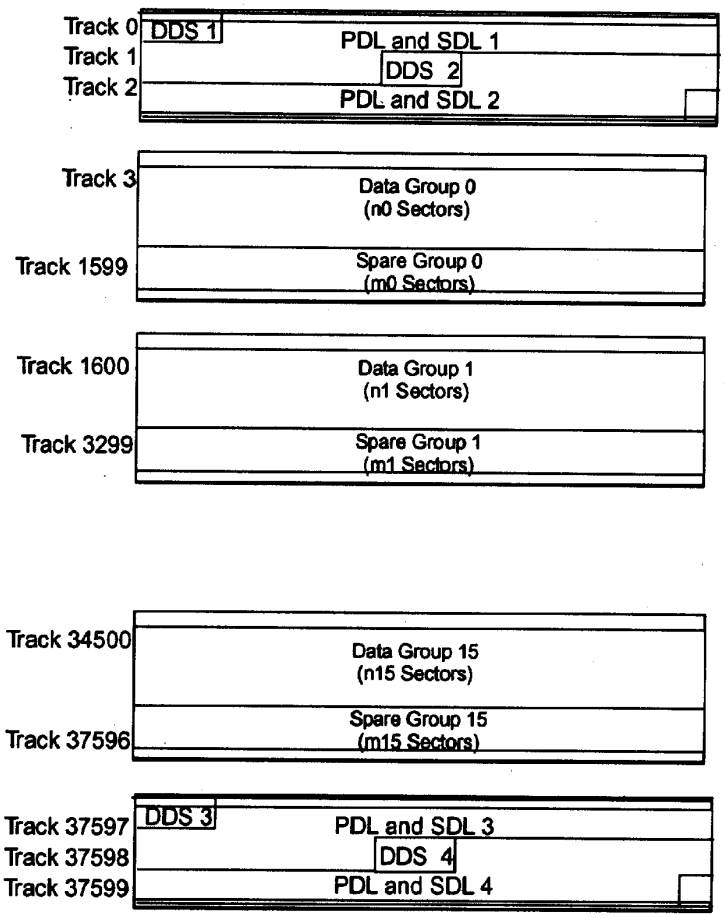


Table 6–1 Values for n and m for 1.3-Gbyte with g=16 (1024 media)

Band	n	m
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. The following table details the physical revolution to logical track layout for 1.3-Gbyte media.

Table 6–2 Physical Revolution to Logical Track Layout

Zone or Band	Physical Revolution Range	Logical Track Range
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)
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)

Table 6–2 Physical Revolution to Logical Track Layout (continued)

Zone or Band	Physical Revolution Range	Logical Track Range
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)

Figure 6–9 User Zone Layout for 2.6-Gbyte, 1024 bytes/sector

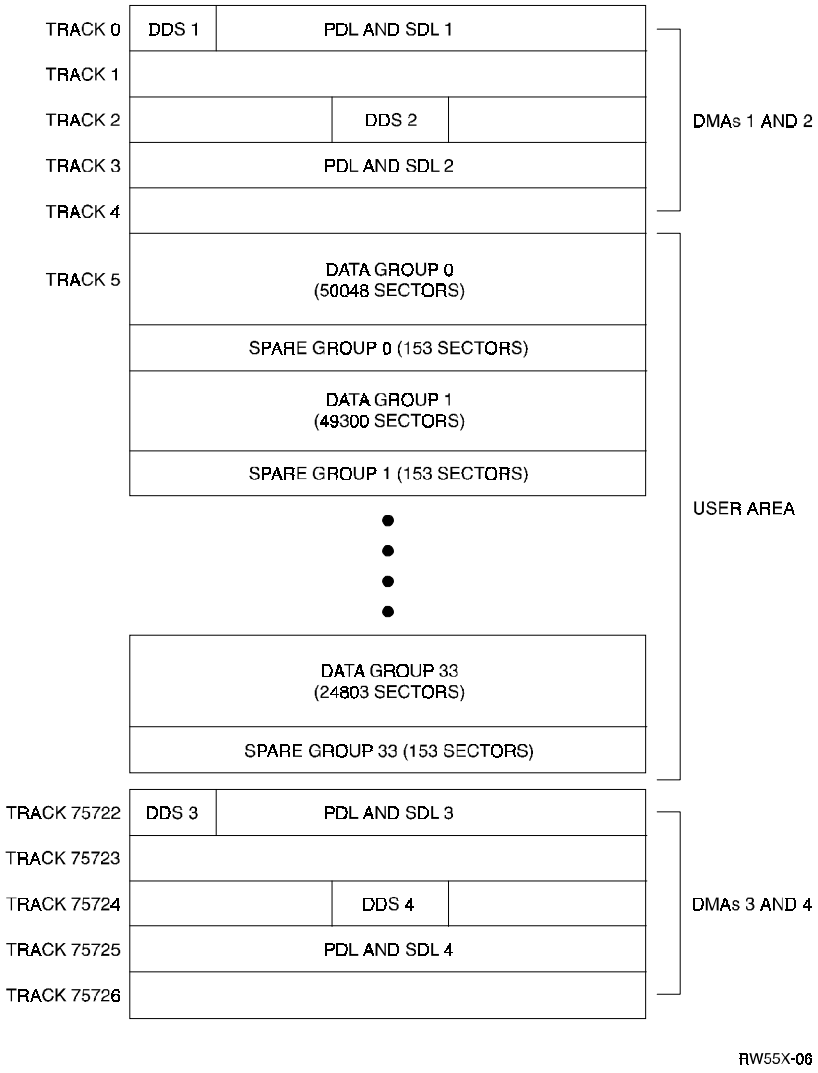


Figure 6–10 User Zone Layout for 2.3-Gbyte, 512 bytes/sector

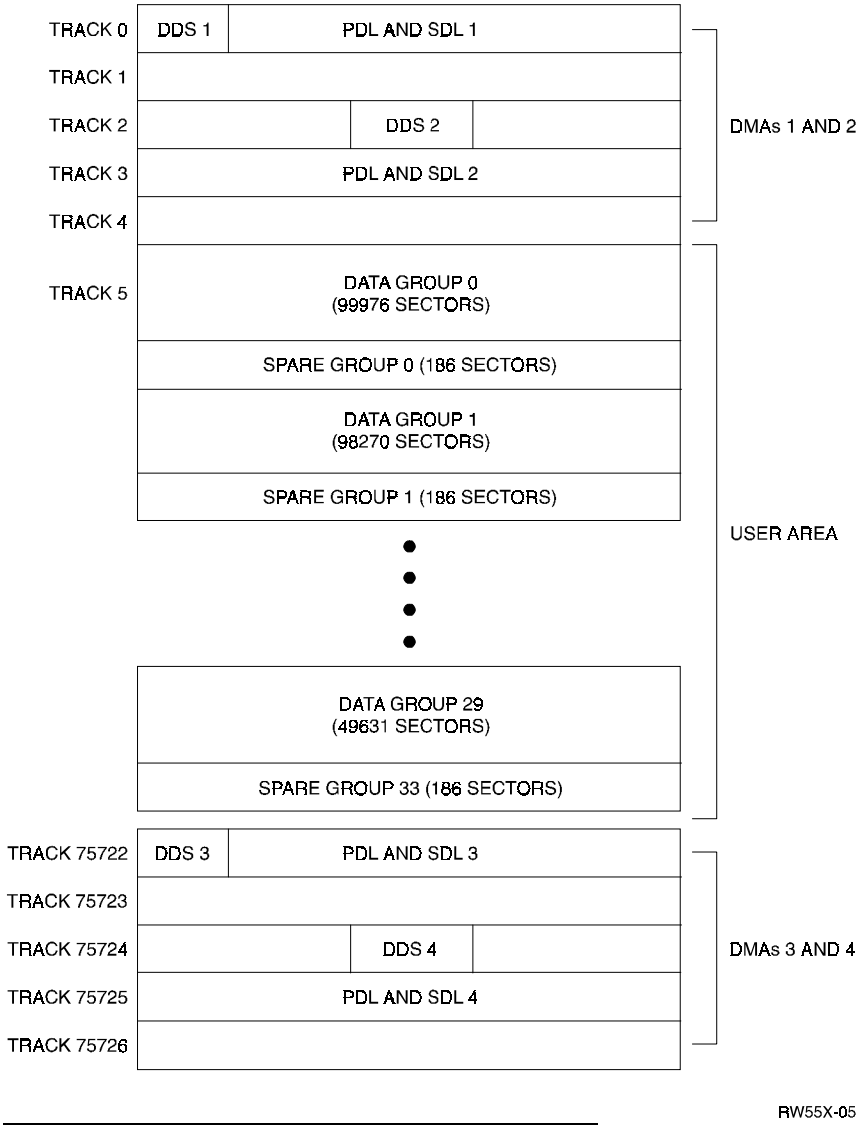


Table 6–3 4X 1,024 Bytes/Sector Disk Structure

Zone#	Start Track	End Track	No. Track	No. LBAs	Start LBA	End LBA
0	5	2948	2944	50048	0	50047
1	2974	5873	2900	49300	50048	99347
2	5899	8753	2855	48535	99348	147882
3	8779	11588	2810	47770	147883	195652
4	11614	14378	2765	47005	195653	242657
5	14404	17123	2720	46240	242658	288897
6	17149	19823	2675	45475	288898	334372
7	19849	22478	2630	44710	334473	379082
8	22504	25088	2585	43945	379083	423027
9	25114	27653	2540	43180	423028	466207
10	27679	30173	2495	42415	466208	508622
11	30199	32648	2450	41650	508623	580272
12	32674	35078	2405	40885	550273	591157
13	35104	37463	2360	40120	591158	631277
14	37489	39803	2315	39355	631278	670632
15	39829	42098	2270	38590	670633	709222
16	42124	44348	2225	37825	709223	747047
17	44374	46553	2180	37060	747048	784107
18	46579	48713	2135	36295	784108	820402
19	48739	50828	2090	35530	820403	855932
20	50854	52898	2045	34765	855933	890697
21	52924	54923	2000	34000	890698	924697
22	54949	56903	1955	33235	924698	957932
23	56929	58838	1910	32470	957933	990402
24	58864	60728	1865	31705	990403	1022107
25	60754	62573	1820	30940	1022108	1053047
26	62599	64373	1775	30175	1053048	1083222
27	64399	66128	1730	29410	1083223	1112632
28	66154	67838	1685	28645	1112633	1141277
29	67864	69503	1640	27880	1141278	1169157

Table 6–3 4X 1,024 Bytes/Sector Disk Structure (continued)

Zone#	Start Track	End Track	No. Track	No. LBAs	Start LBA	End LBA
30	69529	71123	1595	27115	1169158	1196272
31	71149	72698	1550	26350	1196273	1222622
32	72724	74228	1505	25585	1222623	1248207
33	74254	75712	1459	24803	1248208	1273010

Table 6–4 4X 512 Bytes/Sector Disk Structure

Zone#	Start Track	End Track	No. Track	No. LBAs	Start LBA	End LBA
0	5	3229	3225	99975	0	99974
1	3252	6421	3170	98270	99975	198244
2	6444	9557	3114	96534	198245	294778
3	9580	12637	3058	94798	294779	389576
4	12660	15661	3002	93062	389577	482638
5	15684	18629	2946	91326	482639	573964
6	18652	21541	2890	89590	573965	663554
7	21564	24397	2834	87854	663555	751408
8	24420	27197	2778	86118	751409	837526
9	27220	29941	2722	84382	837527	921908
10	29964	32629	2666	82646	921909	1004554
11	32652	35261	2610	80910	1004555	1085464
12	35284	37837	2554	79174	1085465	1164638
13	37860	40357	2498	77438	1164639	1242076
14	40380	42821	2442	75702	1242077	1317778
15	42844	45229	2386	73966	1317779	1391744
16	45252	47581	2330	72230	1391745	1463974
17	47604	49877	2274	70494	1463975	1534468
18	49900	52117	2218	68758	1534469	1603226
19	52140	54301	2162	67022	1603227	1670248
20	54324	56429	2106	65286	1670249	1735534

Table 6–4 4X 512 Bytes/Sector Disk Structure (continued)

Zone#	Start Track	End Track	No. Track	No. LBAs	Start LBA	End LBA
21	56452	58501	2050	63550	1735535	1799084
22	58524	60517	1994	61814	1799085	1860898
23	60540	62477	1938	60078	1860899	1920976
24	62500	64381	1882	58342	1920977	1979318
25	64404	66229	1826	56606	1979319	2035924
26	66252	68021	1770	54870	2035925	2090794
27	68044	69757	1714	53134	2090795	2143928
28	69780	71437	1658	51398	2143929	2195326
29	71460	73060	1601	49631	2195327	2244957

Table 6–5 Technical Comparisons of 1X, 2X, and 4X Optical Drives

Item	1X	2X	4X
bytes per sector	1,024 (512)	1,024 (512)	1,024 (512)
track pitch	1.60	1.39	1.15
spiral direction	outward	outward	inward
data encoding	(2, 7) RLL	(2, 7) RLL	(1, 7) RLL
channel bits per byte	16	16	12
raw bytes per sector	1,360 (746)	1,360 (746)	1,410 (799)
headers aligned	yes	no	yes
sectors per revolution ID	17 (31)	20.1 (36.7)	33 (58)
sectors per revolution OD	17 (31)	40.3 (73.5)	66 (116)
modulation method	PPM	PPM	PWM
bit density ID (bpi)	24.9K	29.5K	48.7K (49.1K)
bit density OD (bpi)	12.5K	29.5K	50.9K (50.9K)
sectors per logical track	17 (31)	17 (31)	17 (31)
number of user bands	1	16	34 (30)
physical tracks per band	18,751	1,350	765 (868)
physical tracks per user zone	18,751	21,600	26,010 (26,040)
logical tracks per user zone	18,751	37,473 (37,527)	75,732 (73,077)
logical tracks per band ID		1.600	1,485 (1,624)
logical tracks per band OD		3,100	2,970 (3,248)
number of sectors for spares	4,096	2,057 (2,077)	5,287 (6,479)
number of buffer/test sectors	0	0	9,112 (16,616)
number of sectors for DMAs	102 (186)	102 (186)	170 (310)
usable capacity per disk (GB)	0.644 (0.591)	1.300 (1.189)	2.607 (2.296)

Drive Defect Management

The RWZ53 drive 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 used 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/IEC 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.)

In general for 2.6-Gbyte: g=34 or 30. (n, m or n0 through n33/29 and m0 through m33/29 are predefined based on g)

For 1.3-Gbyte the value for g must be 1 or 16.

In general for 650-Mbyte: g * (n + m) <= (size of User Area)

In general for 1.3-Gbyte: g = 1 or 16, (n, m or n0 through n15 and m0 through m15 are predefined based on g).

For more details consult the ISO or ECMA standard.

The PDL contains a list of defective sector addresses as determined by the manufacturer or by a certification of the User Area, i.e. during a SCSI Format Unit Command. Defective sectors listed 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.

NOTE

The Slipping Area applies only to 650-MB media.

Slip Sparing Algorithm

The slip sparing algorithm is used to manage the defective sectors listed in the PDL during address translation between logical and physical blocks. During an address translation, the logical blocks are "slipped" past any defective sectors, thus the name slip sparing. As an example, suppose there are defective sectors at physical block addresses 20 and 30, and the user wants the physical address of logical block 40. Since physical addresses 20 and 30 have defective sectors 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.

This is not a truly accurate example for the following 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 and 2.6-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 and 2.6-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.

Replacement Sparing Algorithm

The replacement sparing algorithm is intended to manage defective sectors found after initialization.

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 sec-torso" 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 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/replacemet pair is added to the SDL (if the new defect is not already in the SDL) or an existing defect/replacement entry is updated if it already exists in the SDL.

(Updating an existing defect/replacement pair only occurs on 650-Mbyte media. For 1.3 and 2.6-Gbyte media a new defect/replacement pair is added, thus creating a "chain" of defect/replacement pointers.)

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.

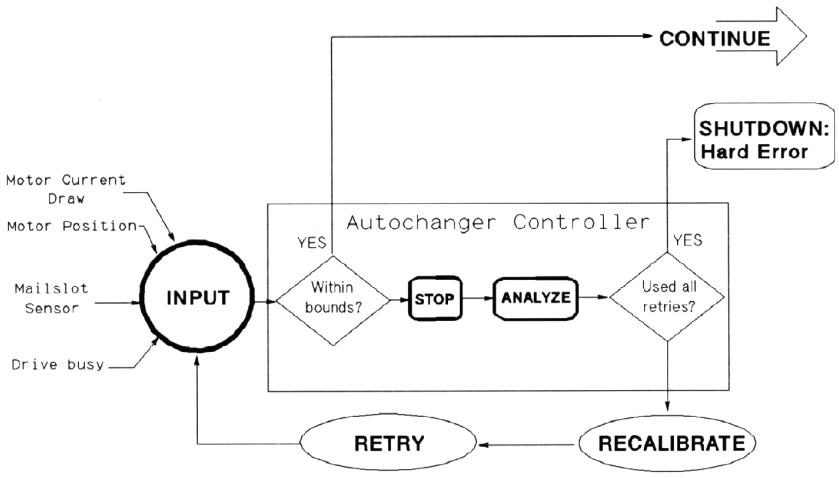
Table 6–6 shows the error thresholds for the RWZ53 optical drive. The sector IDs column refers to the minimum number of sector IDs that must be read correctly for the corresponding operation to be deemed successful. The ECC level column refers to the maximum number of bytes per interleave that require correction in order for the corresponding operation to be deemed successful.

Table 6–6 Error Thresholds

Operation	Sector IDs	ECC Level
Format	C1716T=2	3
	C1113=1	-
Write	2	-
Erase	2	-
Verify	2	4
Read (recovered)	1	7
Read	1	8

Error Detection and Recovery

Figure 6–11 Error Detection and Recovery



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 hardwired 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 sensor - detect conditions that are otherwise difficult to detect. There are two mailslot sensors to detect if a cartridge is properly inserted into the mailslot.

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 poweron, 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 poweron, 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.

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 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 mechanics do not move.

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, and the disk must be returned to the appropriate location (element).

The picker "element status" always reflects the physical state of the picker. The autochanger does not give a status when the picker is found unexpectedly full or empty because this logical error is not allowed. At poweron, 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 poweron 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.

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.

Hardware Error Codes are listed in Chapter 4, "Troubleshooting/Diagnostics" under "Recovery from Hardware Errors."

Real Time Event Logging

Logs

The jukebox provides information logs about its operation and error history. These logs provide predictive information that can lead to early detection of autochanger problems.

All 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 error that have occurred within the autochanger, along with a time stamp of when they occurred. The error message maintained for each error indicates the failure and the possible FRUs that 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 measure 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 the drive.

Runtime Log

An entry is put into this log each time an error occurs that 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 recorded.

Diagnostic Strategy

Internal Autochanger Diagnostics

The diagnostic tests provided by the jukebox provide diagnostic capabilities that are not available in the standard set of SCSI autochanger commands. The tests may be run individually or as a sequence of tests.

Offline Diagnostics

DOSDASS2 is a PC-based diagnostic that fully exercises both the autochanger and the drive mechanisms.

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.

CAUTION

DO NOT CYCLE POWER during any trouble-shooting 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.

Single-Ended versus Differential SCSI Interfaces

The Model RW525 jukebox is available with a either a single-ended or a differential SCSI interface. If equipped with a differential interface externally, this is changed to single-ended by a converter PCA inside the power supply module.

With a single-ended SCSI interface, the total SCSI cable length between peripherals and the host is 6 meters. In addition, an internal SCSI cable length of 1.45 meters must be included in this calculation.

A single-ended SCSI interface may be preferable when peripherals are physically close to the host and short SCSI cables are adequate to connect (or daisy-chain) them. An example of an appropriate use of a single-ended SCSI inter-face is when a host and several peripherals are daisy-chained and located in an upright cabinet with 1-meter cables connecting them.

Differential SCSI Interface

The differential SCSI interface specifies the use of a differential SCSI converter PCA. This PCA enables the jukebox to be connected to an external differential SCSI bus. The differential SCSI converter 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 25 meters usually allowed on a differential SCSI bus.

A differential SCSI interface is used when up to 15 meters of SCSI cabling is needed, and the peripherals need to be physically located farther apart than the single-ended SCSI interface allows. An example of an appropriate use of a differential SCSI interface is when a peripheral must be located in a different location than the host system for security reasons or for user convenience.

The differential SCSI interface may also be used in a hardware setup that produces noise on the SCSI bus, since this interface has better noise immunity.

SCSI Command Set

The following SCSI-2 commands, listed numerically by group, can be used with the optical disk jukebox.

NOTE

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

- 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 Kendall Printing, call (970) 330-8895. Refer to Appendix A for Order information.

Optical Drives and Libraries Technical Guide, obtained by ordering part number 5960-7605 from Kendall Printing, call (970) 330-8895. Refer to Appendix A for Order information..

Table 6–7 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 recali-bration 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
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 physi-cal 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

Table 6–7 Group 0 Commands (6-byte command) (continued)

Code (Hex.)	Name	Description
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 p optical disk in the logical unit
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
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

Table 6–7 Group 0 Commands (6-byte command) (continued)

Code (Hex.)	Name	Description
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 control- unit parameters
5A	Mode Sense	Reads optical disk, drive unit, or controller unit parameters
A8	Read	Reads data from the specified logiical 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

Reader's Comments

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