RA82 Disk Drive
User Guide
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About This Manual

This manual contains a product description and operating information for the end user of the RA82 disk drive. Drive specifications are included in the introductory material of this manual.

Installation instructions in this manual are for use by DIGITAL field service engineers performing original installation of the RA82 disk drive.
1.1 GENERAL INFORMATION

The RA82 is a movable-head disk drive with non-removable recording media. The RA82 is a member of the Digital Storage Architecture (DSA) family and can be connected to any controller that uses the Standard Disk Interconnect (SDI) cable and protocol.

Each RA82 has a data storage capacity of 623 megabytes in 16-bit word format (PDP-11 and VAX systems). Other features of the RA82 disk drive follow:

Performance
• 19.2 megabits per second transfer rate
• 24 milliseconds average seek time

Data integrity
• Protected (sealed) media
• Microprocessor-controlled servo
• SDI-invoked error recovery hardware

Hardware
• Simple modular construction
• Reduced field replaceable unit (FRU) set
• Rugged design
• Two internal microprocessors

Maintainability
• Improved and easy service access
• No scheduled preventive maintenance
• Extensive internal microcode diagnostics
• Access to RS232 diagnostic terminal port behind front cover
1.2 DATA BACKUP

Some method of backup must be used on fixed media drives to prevent loss of data in the event of a system failure. The following methods of backup are recommended for the RA82:

- **File Duplication** - normally involves copying the data on removable media such as magnetic tape.
- **Journaling** - recommended for files in a transaction processing application. Allows reconstruction of files up to the last checkpoint or backup.

1.3 DRIVE DESCRIPTION

The RA82 is a self-contained disk drive. Logic modules, dc power supply, and a cooling system are all within the drive cabinet. Figure 1–1 shows an RA82 disk drive.

Figure 1–1  RA82 Disk Drive

The logic modules are made up of three removable circuit board assemblies (hybrid, servo, and read/write module) that can be folded out for ease of service (Figure 1–2).
Figure 1–2  Hinged Circuit Module Arrangement

The dc power supply is located inside the back of the drive. The supply provides the dc operating power for the logic circuits. A cooling system which includes internal fans provides air circulation for the power supply and other drive components.

In addition, the RA82 houses the head disk assembly (HDA), a sealed unit inside the drive which contains and protects the recording media, and a rotary positioner, read/write heads, and a preamplifier module.
The drive also has slide rails designed to be fitted to a 19-inch wide RETMA equipment rack. This type of rack is housed inside a 60-inch high cabinet that holds up to four drives (mounted on slides) or a 40-inch high cabinet that holds up to three drives (one fix-mounted and two mounted on slides).

The drive recording media is made up of four disk platters. Each platter contains two recording surfaces, upper and lower, for a total of eight surfaces. Seven of the disk surfaces are for data storage only; the remaining surface is equally shared between data and dedicated servo information. Figure 1–3 shows these disk surfaces.

Additional servo information, called embedded servo, is written before each block of data on the data surfaces. Both types of servo information are created on the disks when the HDA is manufactured.

The heads are mounted on a rotary positioner which moves in an arc over the recording surfaces. The drive has sixteen heads (two per data surface): fifteen for reading and writing data and one for reading the dedicated servo. Figure 1–3 shows the head arrangement. To position the heads over the desired data location, the RA82 reads the servo information and moves the positioner accordingly.

Attached to the outside of the HDA are the read/write and preamplifier modules. The read/write module, located on top of the HDA, works with the preamplifier module to select read/write heads, generate write-drive current, amplify read signals, and monitor unsafe conditions in the HDA. (Refer to Figure 1–2 for module locations.)

### 1.3.1 Physical and Logical Media Layout

Each of the read/write heads accesses a group of concentric tracks. The tracks under the heads at any instant are grouped together into a logical cylinder. (In other words, a logical cylinder consists of all the tracks that can be read without moving the positioner.)

A track is divided into a number of sectors each of which contains a fixed number of bytes. A sector is the equivalent of a logical block. At the end of each sector is an error detection code (EDC) which is used by the controller for detecting errors, and an error correction code (ECC) which can reconstruct data bits that were lost or garbled. One sector of each track (the last sector in LBN and RCT space) is a spare which can be used to replace a weak or corrupted sector. Each of these spare sectors is assigned a replacement block number (RBN). A map of these replaced sectors is maintained on a designated part of the media called the replacement control table (RCT).

The controller converts each logical block number (LBN) into logical cylinders, groups, tracks, and physical sectors.

The physical structure of the media format is invisible to the user. The controller keeps track of where the data is physically stored. An LBN with bad or suspect data is flagged for replacement/relocation. The controller automatically replaces the flagged LBN with a spare sector. Thus, the host computer sees the disk subsystem as a collection of continuous logical blocks.

Figure 1–4 shows the physical and logical layout of the media. Figure 1–5 shows disk media geometry.
### Figure 1–3  HDA Head Arrangement

#### 1.3.2 Media Format

Each of the read/write heads can address 1435 cylinders (numbered 0 through 1434). There are 58 sectors (numbered 0 to 57) per track in 16-bit word format. Each sector includes information encoded in a header preceding the data to identify the type of block (LBN, RBN, XBN or DBN) and block number.
Figure 1–4  Physical and Logical Media Layout

Figure 1–6 shows the RA82 sector format details.

The RA82 employs a sector offset method to compensate for rotational latency during head switching.

1.3.3 Internal Microprocessors

The RA82 has a dual (master and slave) microprocessor control system. Except for the read and write operations, the microprocessors control and/or monitor all primary functions of the disk drive. The slave handles the mechanical functions of the drive (such as head loading, servo positioning, and motor control). The master manages and monitors overall drive functions and handles SDI communication. Both microprocessors share diagnostic responsibilities.
Figure 1–5  Disk Geometry
1.4 INTERNAL DRIVE DIAGNOSTICS

Most RA82 self-diagnostics execute during drive power-up and spin-up. Internal LED indicators on the hybrid module (Figure 1–2) display the results of the self tests.

The remaining diagnostics are initiated and monitored by field service engineers using a diagnostic terminal. The drive performs these diagnostics in an offline mode or through SDI diagnostic requests from the controller in an online mode to the controller.

Refer to Chapter 3 for additional information on the internal drive diagnostics and to Appendix A for a list of LED error codes.

1.5 CONTROLLER AND DRIVE CONFIGURATIONS

An RA82 disk drive subsystem consists of an SDI controller (or two controllers in a dual-port configuration) and one or more disk drives. Figure 1–7 shows the relationship between the subsystem components.

Connections between the SDI controller and the RA82 disk drive are illustrated in Figure 1–8. The standard RA82 dual-port feature permits a second controller to be connected to a single drive and provides shared access of the drive between the two controllers (Figure 1–9). In this arrangement, called static dual-porting, the controller accesses only one drive at a time. The controller accessing the drive must relinquish its ownership of the drive before the other controller can access it.

NOTE
A drive can be dual-ported between two controllers only if supported by system software. If each controller is connected to a different host computer, both operating systems must use the same word format and file structure as well as support the dual-port feature.
1.6 RA82 SPECIFICATIONS

Table 1-1 contains the primary performance, power, environmental, and physical characteristics of the RA82 disk drive.

CAUTION
The term operating in Table 1-1 indicates values not to be exceeded while the drive is operational. The term nonoperating indicates values not to be exceeded when the drive is being stored. Exceeding these values may damage the drive.

Table 1-2 and Table 1-3 show typical measured values of the RA82.
Figure 1-8  Single Port, Multi-Drive Configuration
Figure 1–9  Dual-Port Configuration
### Table 1-1 RA82 Specifications

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data storage capacity (Host Applications Area)</td>
<td></td>
</tr>
<tr>
<td>single drive</td>
<td></td>
</tr>
<tr>
<td>16-bit word format</td>
<td>622.93 megabytes (formatted)</td>
</tr>
<tr>
<td>Media type</td>
<td></td>
</tr>
<tr>
<td>Number of spindles</td>
<td>1</td>
</tr>
<tr>
<td>Number of disk platters/spindle</td>
<td>4</td>
</tr>
<tr>
<td>Disk surfaces/spindle</td>
<td></td>
</tr>
<tr>
<td>Number of heads/spindle</td>
<td>15 data, 1 servo</td>
</tr>
<tr>
<td>Heads per disk surface</td>
<td>2</td>
</tr>
<tr>
<td>Logical cylinders per head</td>
<td>1438</td>
</tr>
<tr>
<td>(Non-DSA formatted)</td>
<td></td>
</tr>
<tr>
<td>Sectors per track</td>
<td>58</td>
</tr>
<tr>
<td>(16-bit format)</td>
<td></td>
</tr>
<tr>
<td>Tracks per logical group</td>
<td>1</td>
</tr>
<tr>
<td>Groups per logical cylinder</td>
<td>15</td>
</tr>
<tr>
<td>Performance characteristics</td>
<td></td>
</tr>
<tr>
<td>Disk encoding method</td>
<td>2/3</td>
</tr>
<tr>
<td>Recording density</td>
<td></td>
</tr>
<tr>
<td>Tracks per inch</td>
<td>1063</td>
</tr>
<tr>
<td>Bits per inch</td>
<td>12,800 bits per inch; 9,624 flux changes per inch at inner track</td>
</tr>
<tr>
<td>Bytes per track</td>
<td>40,000 (unformatted)</td>
</tr>
<tr>
<td>Transfer rate (bit rate)</td>
<td>19.2 megabits per second nominal/spindle</td>
</tr>
<tr>
<td>Bit cell period</td>
<td>52.08 nanoseconds nominal</td>
</tr>
<tr>
<td>Data rate</td>
<td>2.4 megabytes per second nominal (burst)/spindle</td>
</tr>
<tr>
<td>Read initialization time</td>
<td></td>
</tr>
<tr>
<td>Write-to-read recovery</td>
<td>10 microseconds excluding data separator sync</td>
</tr>
<tr>
<td>Read-to-write recovery</td>
<td>1 microsecond</td>
</tr>
<tr>
<td>Data separator synchronization</td>
<td>10 microseconds</td>
</tr>
<tr>
<td>Rotational latency</td>
<td></td>
</tr>
<tr>
<td>Rotational speed</td>
<td>3600 r/min +2.5%, -3.5%</td>
</tr>
<tr>
<td>Average rotational latency</td>
<td>8.33 milliseconds</td>
</tr>
<tr>
<td>Maximum rotational latency</td>
<td>16.66 milliseconds</td>
</tr>
<tr>
<td>Head switch latency (time to switch heads on a given cylinder)</td>
<td>6 milliseconds maximum</td>
</tr>
<tr>
<td>Average seek</td>
<td>24 milliseconds</td>
</tr>
<tr>
<td>One cylinder seek</td>
<td>6 milliseconds maximum</td>
</tr>
<tr>
<td>Maximum seek</td>
<td>38 milliseconds maximum (1435 tracks)</td>
</tr>
<tr>
<td>Disk rotation start/stop times</td>
<td></td>
</tr>
</tbody>
</table>
Table 1–1 (Cont.) RA82 Specifications

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start time</td>
<td>50 seconds (to ready) maximum</td>
</tr>
<tr>
<td>Stop time</td>
<td>20 seconds maximum</td>
</tr>
<tr>
<td>Maximum start/stop frequency</td>
<td>6 minutes (3 minutes between cycles with the drive powered up and ready during one of the three-minute cycles)</td>
</tr>
</tbody>
</table>

Physical characteristics (drive only)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Width (nominal)</td>
<td>44.5 centimeters (17.5 inches)</td>
</tr>
<tr>
<td>Depth (nominal)</td>
<td>67.3 centimeters (26.5 inches)</td>
</tr>
<tr>
<td>Height (nominal)</td>
<td>26.4 centimeters (10.4 inches)</td>
</tr>
<tr>
<td>Weight (approximate)</td>
<td>61.2 kilograms (135 pounds)</td>
</tr>
</tbody>
</table>

Environmental limits (maximum)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature Operating</td>
<td>10 to 40 degrees C (50 to 104 degrees F) with a temperature gradient of 20 degrees C/hour (36 degrees F/hour)</td>
</tr>
<tr>
<td>Nonoperating</td>
<td>-40 to +60 degrees C (-40 to +140 degrees F)</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>10% to 85% (noncondensing) with a maximum wet bulb temperature of 28 degrees C (82 degrees F) and a minimum dew point of 2 degrees C (36 degrees F)</td>
</tr>
<tr>
<td>Operating</td>
<td>10% to 85% with no condensation</td>
</tr>
<tr>
<td>Altitude Operating</td>
<td>Sea level to 2438 meters (8000 feet) above sea level. Maximum allowable temperatures are reduced by a factor of 1.8 degrees F/1000 meters (1 degree C/1000 feet) for operation at higher altitude sites</td>
</tr>
<tr>
<td>Nonoperating</td>
<td>300 meters (1000 feet) below sea level to 9175 meters (30,000 feet) above sea level (actual or by means of cabin pressurization)</td>
</tr>
</tbody>
</table>

Environmental limits (recommended range)

---
Table 1-1 (Cont.) RA82 Specifications

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>The following environmental</td>
<td>18 to 24 degrees C (64.4 to 75.2 degrees F) with an average rate of change of</td>
</tr>
<tr>
<td>limits are the recommended</td>
<td>3 degrees C/hour maximum and a step change of 3 degrees C or less.</td>
</tr>
<tr>
<td>range for optimum equipment</td>
<td></td>
</tr>
<tr>
<td>performance and reliability:</td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>40% to 60% (noncondensing) with a step change of 10% or less (noncondensing).</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>Not to exceed 500,000 particles per cubic foot of air at a size of .5 micron</td>
</tr>
<tr>
<td>Air quality (maximum particle</td>
<td>or larger</td>
</tr>
<tr>
<td>count)</td>
<td></td>
</tr>
<tr>
<td>Air volume (at inlet)</td>
<td>50 cubic feet per minute (.026 cubic meters per second)</td>
</tr>
</tbody>
</table>

RA82 disk drive ac voltage requirements, single phase

<table>
<thead>
<tr>
<th>Voltage Configuration</th>
<th>Voltage/Frequency Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>120 volt, 60 Hz drives</td>
<td>90 to 128 volts ac, 60 ± 1 Hz</td>
</tr>
<tr>
<td>220/240 volt, 50 Hz drives</td>
<td>184 to 256 volts ac, 50 ± 1 Hz</td>
</tr>
</tbody>
</table>

Current requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starting current for 120 volt ac drives</td>
<td>35 ampere peak surge for 4 seconds</td>
</tr>
<tr>
<td>Running current for 120 volt ac drives</td>
<td>7.8 amperes rms at 120 volts</td>
</tr>
<tr>
<td>Starting current for 220 to 240 volt ac</td>
<td>18 ampere peak surge for 4 seconds</td>
</tr>
<tr>
<td>drives</td>
<td>3.5 amperes rms at 240 volts</td>
</tr>
<tr>
<td>Running current for 220 to 240 volt ac</td>
<td>936 watts</td>
</tr>
<tr>
<td>drives</td>
<td>840 watts</td>
</tr>
<tr>
<td>Running power for 120 volt ac drives</td>
<td></td>
</tr>
<tr>
<td>Running power for 220 to 240 volt ac drives</td>
<td></td>
</tr>
</tbody>
</table>

Power factor

| Power factor | 0.65 minimum |

Line cord length

| From cabinet | 259 cm (8.5 feet) |

DC voltage tolerance

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Tolerance Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>+5 volts</td>
<td>+4.75 to +5.25 volts dc (+5 volts ± 5%)</td>
</tr>
<tr>
<td>-5.2 volts</td>
<td>-5.04 to -5.56 volts dc (-5.2 volts ± 5%)</td>
</tr>
<tr>
<td>+24 volts</td>
<td>+23.0 to +27.0 volts dc (+24 volts unregulated, ± 3% long term stability)</td>
</tr>
<tr>
<td>-24 volts</td>
<td>-23.0 to -27.0 volts dc (-24 volts unregulated, ± 3% long term stability)</td>
</tr>
</tbody>
</table>
Table 1–2  RA82 Typical Measured Values, Table I

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Inrush Current First Half Cycle (peak)</th>
<th>Surge Current (startup peak)</th>
<th>Surge Duration (startup)</th>
<th>Power On (I)</th>
<th>Heads Loaded (I)</th>
</tr>
</thead>
<tbody>
<tr>
<td>184 V (50 Hz)</td>
<td>23 amps</td>
<td>10 amps</td>
<td>80 msec</td>
<td>1.5 amps</td>
<td>3.0 amps</td>
</tr>
<tr>
<td>240 V (50 Hz)</td>
<td>38 amps</td>
<td>15 amps</td>
<td>30 msec</td>
<td>1.6 amps</td>
<td>3.5 amps</td>
</tr>
<tr>
<td>256 V (50 Hz)</td>
<td>62 amps</td>
<td>18 amps</td>
<td>30 msec</td>
<td>1.9 amps</td>
<td>3.8 amps</td>
</tr>
<tr>
<td>90 V (60 Hz)</td>
<td>40 amps</td>
<td>15 amps</td>
<td>130 msec</td>
<td>3.2 amps</td>
<td>10 amps</td>
</tr>
<tr>
<td>120 V (60 Hz)</td>
<td>90 amps</td>
<td>35 amps</td>
<td>45 msec</td>
<td>3.3 amps</td>
<td>7 amps</td>
</tr>
<tr>
<td>128 V (60 Hz)</td>
<td>98 amps</td>
<td>40 amps</td>
<td>45 msec</td>
<td>3.6 amps</td>
<td>8 amps</td>
</tr>
</tbody>
</table>

Table 1–3  RA82 Typical Measured Values, Table II

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Watts (Heads loaded)</th>
<th>Watts (Powered On)</th>
<th>BTU/Hr. (Heads loaded)</th>
<th>BTU/Hr. (Powered On, HDA Stopped)</th>
</tr>
</thead>
<tbody>
<tr>
<td>184 V (50 Hz)</td>
<td>490</td>
<td>277</td>
<td>1672</td>
<td>945</td>
</tr>
<tr>
<td>240 V (50 Hz)</td>
<td>560</td>
<td>308</td>
<td>1911</td>
<td>1051</td>
</tr>
<tr>
<td>256 V (50 Hz)</td>
<td>600</td>
<td>323</td>
<td>2047</td>
<td>1102</td>
</tr>
<tr>
<td>90 V (60 Hz)</td>
<td>500</td>
<td>286</td>
<td>1706</td>
<td>976</td>
</tr>
<tr>
<td>120 V (60 Hz)</td>
<td>560</td>
<td>310</td>
<td>1911</td>
<td>1058</td>
</tr>
<tr>
<td>128 V (60 Hz)</td>
<td>593</td>
<td>320</td>
<td>2023</td>
<td>1092</td>
</tr>
</tbody>
</table>

1.7 ELECTROSTATIC DISCHARGE (ESD)

Electrostatic discharge (ESD) is caused by the buildup and release of static electricity (the surface storage of an electrical charge on a person or an inanimate object). The effects of static electricity on equipment are subtle. Damage may be caused from the static on a person and also by the static field that is emanated from a person. Some components don't have to be touched to become damaged by static electricity. This is especially true of delicate oxide layers that, when damaged, can cause equipment to perform intermittently or fail.
1.7.1 Electrostatic Protection

The basic concept of complete static electricity protection for electronic components is the prevention of static buildup, where possible, and the quick, reliable removal of existing charge. If the charged object is a conductor, such as a conductive bag or person, complete discharge can be achieved by grounding.

CAUTION
For drive protection, a grounding (electrostatic discharge) wrist strap must be used when handling drive modules and components.

The following are required of all individuals who handle or work with this equipment:

- Proper grounding when handling modules, components, or static-sensitive devices. Establishing zero voltage potential between people and devices being handled.
- Transferring modules and components in static-protective containers (totes, boxes, and bags).
- Implementing and maintaining proper static control training certification.

NOTE
Read all instructions and installation procedures included with the static control materials and kits. If part numbers for static control materials and demonstration kits are needed, refer to Appendix B.

Figure 1–10 shows the electrostatic wrist strap in use. Notice the fastener on one end of the grounding cord and the alligator clip on the other. The grounding cord connects the wrist strap and the conductive work surface to ground.

When using an ESD wrist strap:

- Make sure the wrist strap fits snugly to assure conductivity.
- Never overextend the grounding cord. Use a longer grounding cord if necessary.
- Attach the alligator clip securely to a clean, unpainted, grounded metal surface such as the drive chassis.

1.8 RELATED DOCUMENTATION

Table 1–4 contains a list of related RA82 documentation.
Figure 1–10  Connecting ESD Wrist Strap to Ground

Table 1–4  Related Documentation

<table>
<thead>
<tr>
<th>Document Title</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSC Disk Controller User Guide</td>
<td>AA-GMEAA-TK</td>
</tr>
<tr>
<td>KDA50 Disk Controller User Guide</td>
<td>EK-KDA5Q-UG</td>
</tr>
<tr>
<td>KDB50 Disk Controller User Guide</td>
<td>EK-KDB50-UG</td>
</tr>
<tr>
<td>UDA50 Disk Controller User Guide</td>
<td>EK-UDA50-UG</td>
</tr>
<tr>
<td>DSA Hand Held Terminal User Guide</td>
<td>EK-DSAHH-UG</td>
</tr>
<tr>
<td>H9642-JA/JB Installation Sheet</td>
<td>EK-9642-IN</td>
</tr>
</tbody>
</table>
1.9 ORDERING DOCUMENTATION

Internal DIGITAL customers:
Publication and Circulation Services
10 Forbes Road
Northboro, Massachusetts 01532
(RCS Code: NR12, Mail Code: NR03/W3)

External DIGITAL customers:
Digital Equipment Corporation
P.O. Box CS2008
Nashua, New Hampshire 03061
or by calling toll-free: (800) 258-1710.

Outside the United States, customers should contact one of the following DIGITAL offices:

Europe:
Digital Equipment International BV
Mervue Industrial Estate
Galway, Ireland
Telephone [353]-(91)-51271

Digital Equipment Parts Centre BV
P.O. Box 6774
NL-6503 GG Nijmegen, Netherlands
Telephone [31]-(80)-529911

Far East and General GIA Area:
Accessories and Supplies Group
P.O. Box CS2008
Nashua, New Hampshire, USA 03061
Telephone (603) 844-5111
2 OPERATING INSTRUCTIONS

2.1 CONTROL PANEL SWITCHES AND INDICATORS

Each switch on the operator control panel has an indicator light that displays the drive conditions. The RA82 operator control panel has the following switches and indicators:

- RUN/STOP
- FAULT
- UNIT NUMBER/READY
- WRITE PROT
- A port
- B port

Figure 2–1 shows the arrangement of these controls on the front panel of the drive. Table 2–1 lists the conditions reflected by the state of the indicator lights. The following paragraphs describe these controls and indicators in more detail.

![Diagram of control panel](CX-1013A)

Figure 2–1 Front Panel Controls and Indicators
### Table 2–1 Indicator Conditions

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Turned On</th>
<th>Turned Off</th>
</tr>
</thead>
<tbody>
<tr>
<td>RUN/STOP</td>
<td>When disk is spinning</td>
<td>When disk has stopped</td>
</tr>
<tr>
<td>FAULT</td>
<td>When drive detects a fault</td>
<td>When no faults are detected</td>
</tr>
<tr>
<td>READY</td>
<td>When drive is on cylinder and ready to process host request (RUN light must be on)</td>
<td>When drive cannot process host requests or is not on cylinder (seeking)</td>
</tr>
<tr>
<td>WRITE/PROT</td>
<td>When drive is physically or logically write-protected</td>
<td>When drive is write-enabled</td>
</tr>
<tr>
<td>A</td>
<td>When drive is online to controller A</td>
<td>When drive is not online to controller A</td>
</tr>
<tr>
<td>B</td>
<td>When drive is online to controller B</td>
<td>When drive is not online to controller B</td>
</tr>
</tbody>
</table>

#### 2.1.1 RUN/STOP Switch and Indicator

The RUN/STOP switch is a double-action push button. In the IN (RUN) position, the switch requests a drive spinup and permits initialization of the drive for operation. In the OUT (STOP) position, the heads are moved off the data cylinders and the spindle motor is stopped.

**CAUTION**

If the disk does not spin down after releasing the RUN/STOP switch, contact field service.

Regardless of the switch position, the RUN/STOP indicator light always reflects the state of the drive spindle. That is, the indicator light is on while the spindle is turning and off when it has stopped.

If the RUN/STOP switch is in the run position on powerup, spinup can be initiated either automatically by the controller or by manually toggling the RUN/STOP switch.

If the drive is online and operating when the switch is placed in the stop position, the drive completes all outstanding operations commanded by the controller before spinning down.

**NOTE**

A minimum three-minute delay is recommended between each start and restart to prevent opening the thermal circuit breaker of the spindle motor.
2.1.2 FAULT Switch and Indicator

The FAULT light indicates a fault or error condition within the drive. The FAULT reset switch displays front panel fault codes and clears drive conditions.

NOTE
Some drive conditions cannot be cleared by pressing the FAULT switch.

When the disk drive detects an error, the FAULT light turns on. Some faults are corrected automatically, and the light goes off. If this does not occur, the light stays on and the FAULT button must be pushed. The drive stays in its current operating state until the condition is corrected.

The FAULT button is a momentary contact switch. When pushed the first time, it causes the drive to enter an offline state (relative to the controller) and to assume control of all front panel indicator lights in order to display a blinking front panel fault code (Table 2–2). The drive stays offline as long as the fault code is displayed and the lights are blinking. When the FAULT switch is pushed a second time, the drive tries to clear the condition, enters the available operating state (assuming a port switch is pushed), and returns the front-panel indicators to their normal service.

Front panel fault codes show general fault conditions. Only the most recent or most severe fault codes can be read through the front panel. The LED hexadecimal error codes displayed on the hybrid module (Figure 1–2) show specific error conditions. The error codes are stored in drive memory as the error conditions are cleared. The 16 most recent error codes are stored in the drive internal error silo for use in troubleshooting the drive. Appendix A lists the hybrid LED error codes and associated drive conditions. Error condition hex codes are sent to the controller/host error log. Table 2–2 gives an explanation of the error condition hex codes that are logged in the controller/host error log.

The FAULT indicator is also used for a lamp test. When held in (after hardcore test sequence is completed), all operator control panel lights should illuminate. When released, all lights return to the condition of the drive (last known state or fault code).
Table 2-2 RA82 Front Panel Fault Identification

<table>
<thead>
<tr>
<th>RUN/STOP</th>
<th>FAULT</th>
<th>READY</th>
<th>PROT</th>
<th>A</th>
<th>B</th>
<th>Hex Code*</th>
<th>Error Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>On</td>
<td>-</td>
<td>-</td>
<td>On</td>
<td>-</td>
<td>08</td>
<td>Spindle error</td>
</tr>
<tr>
<td>-</td>
<td>On</td>
<td>-</td>
<td>-</td>
<td>On</td>
<td>-</td>
<td>04</td>
<td>Hybrid fault</td>
</tr>
<tr>
<td>-</td>
<td>On</td>
<td>-</td>
<td>-</td>
<td>On</td>
<td>On</td>
<td>00</td>
<td>SDI error</td>
</tr>
<tr>
<td>-</td>
<td>On</td>
<td>-</td>
<td>On</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>Master/slave error</td>
</tr>
<tr>
<td>-</td>
<td>On</td>
<td>-</td>
<td>On</td>
<td>-</td>
<td>On</td>
<td>18</td>
<td>Servo fine positioning error</td>
</tr>
<tr>
<td>-</td>
<td>On</td>
<td>-</td>
<td>On</td>
<td>-</td>
<td>-</td>
<td>14</td>
<td>Servo coarse positioning error</td>
</tr>
<tr>
<td>-</td>
<td>On</td>
<td>-</td>
<td>On</td>
<td>On</td>
<td>-</td>
<td>1C</td>
<td>Spindle motor interlock error</td>
</tr>
<tr>
<td>-</td>
<td>On</td>
<td>On</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>01</td>
<td>Servo or HDA overtemp error</td>
</tr>
<tr>
<td>-</td>
<td>On</td>
<td>On</td>
<td>-</td>
<td>-</td>
<td>On</td>
<td>09</td>
<td>Read/write unsafe error</td>
</tr>
<tr>
<td>-</td>
<td>On</td>
<td>On</td>
<td>-</td>
<td>On</td>
<td>-</td>
<td>05</td>
<td>Read/write command error</td>
</tr>
<tr>
<td>-</td>
<td>On</td>
<td>On</td>
<td>-</td>
<td>On</td>
<td>On</td>
<td>0D</td>
<td>Servo-HDA-R/W interlock error</td>
</tr>
<tr>
<td>-</td>
<td>On</td>
<td>On</td>
<td>On</td>
<td>-</td>
<td>-</td>
<td>11</td>
<td>Hybrid-servo interlock error</td>
</tr>
<tr>
<td>-</td>
<td>On</td>
<td>On</td>
<td>On</td>
<td>-</td>
<td>On</td>
<td>19</td>
<td>Hybrid-R/W interlock error</td>
</tr>
<tr>
<td>-</td>
<td>On</td>
<td>On</td>
<td>On</td>
<td>On</td>
<td>-</td>
<td>15</td>
<td>Hybrid-OCP interlock error</td>
</tr>
<tr>
<td>On</td>
<td>-</td>
<td>On</td>
<td>On</td>
<td>On</td>
<td>On</td>
<td>**</td>
<td>DC low</td>
</tr>
<tr>
<td>On</td>
<td>On</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>20</td>
<td>Index error</td>
</tr>
<tr>
<td>On</td>
<td>On</td>
<td>-</td>
<td>-</td>
<td>On</td>
<td>-</td>
<td>28</td>
<td>Write and bad embedded servo</td>
</tr>
<tr>
<td>On</td>
<td>On</td>
<td>-</td>
<td>-</td>
<td>On</td>
<td>-</td>
<td>24</td>
<td>Drive disabled by DD bit</td>
</tr>
<tr>
<td>On</td>
<td>On</td>
<td>-</td>
<td>-</td>
<td>On</td>
<td>On</td>
<td>2C</td>
<td>Write and write protect</td>
</tr>
<tr>
<td>On</td>
<td>On</td>
<td>-</td>
<td>On</td>
<td>-</td>
<td>-</td>
<td>30</td>
<td>Servo diagnostics failed</td>
</tr>
<tr>
<td>On</td>
<td>On</td>
<td>-</td>
<td>On</td>
<td>-</td>
<td>On</td>
<td>38</td>
<td>Read/write diagnostics failed</td>
</tr>
<tr>
<td>On</td>
<td>On</td>
<td>-</td>
<td>On</td>
<td>On</td>
<td>-</td>
<td>34</td>
<td>Idle diagnostics failed</td>
</tr>
<tr>
<td>On</td>
<td>On</td>
<td>On</td>
<td>On</td>
<td>On</td>
<td>On</td>
<td>3D</td>
<td>Power-up diagnostics failed</td>
</tr>
</tbody>
</table>

* This hex code represents the code that appears in error log information for drive status byte 15. This hex code is not displayed by the front panel indicator lights.

** The dc low condition prevents code transmission to the controller and, therefore, does not have a hexadecimal code representation for host diagnostic or error logging output.
2.1.3 READY Plug and Indicator

The numbered plastic cap over the READY indicator lamp serves as a unit address plug; it does not contain a switch. The plastic tabs on the rear of this cap provide a binary code which identifies one drive unit from another in multidrive arrangements. See Figure 2–2.

The binary or unit code corresponds to the drive number when plugged into the mating cam-coded switch located behind the READY indicator light. Drive selection is accomplished when the address on the drive select lines matches the code established by the switch cover (Figure 2–3).

The READY indicator lights following a successful (fault-free) spin-up sequence, indicating the drive is up to speed and ready to receive READ/WRITE or SEEK commands. The READY indicator only comes on when the RUN/STOP switch is in the RUN position and the RUN light is on. The READY indicator goes out during seek operations.

NOTE
If both port-select switches (A and B) are placed in the OUT position while the READY indicator is on, the READY indicator goes off. The drive automatically goes into an internal idle loop test sequence any time both port switches are out. During this time, the drive is not ready and the indicator goes on and off intermittently while this self test is being executed.

![Diagram of Drive Unit Address Plug (Ready Cap)](CX-552A)

2.1.4 WRITE PROTect Switch and Indicator

The WRITE PROTect switch is a double-action push button with a built-in indicator light. Pushing IN on this switch places the drive in the write-protect mode and turns on the indicator light. While in the write-protect mode, the drive firmware and logic blocks WRITE-DATA-OPERATION commands. Releasing the push button (OUT) enables the write circuits and turns off the WRITE PROT indicator light.
Figure 2–3 Cam-Coded Switch Cover

2.1.5 Port Select Switches

The RA82 disk drive has two port select push button double-action switches (A and B) with built-in lights. When pushed, these switches light to indicate the port through which the drive is being accessed by the controller. If both port switches are pushed in, either port can be accessed by the controller, though not at the same time. The following three modes can then be selected with the A and B port-select switches:

- Port A operation only
- Port B operation only
- Port A/B (programmable) operation

NOTE
Pushing the port A or B switch does not put the chosen port on line, but only enables that port to the controller. The port is on line when (1) the port switch is in and (2) the controller accesses the port.

Also, both port select switches must be OUT to run internal drive diagnostics.
2.2 REAR POWER CONTROLS

Power control switches are located on the rear of the cabinet power controller and on the rear of the individual disk drives. To gain access to these controls, open the rear door of the cabinet.

The two basic controls on the power controller are the circuit breaker and the Bus/Off/On switch. Refer to Figure 2–4 for four-high (60-inch) cabinets and Figure 2–5 for three-high (40-inch) cabinets. The following paragraphs give the function of each.

NOTE
Always spin down the disk (spindle completely stopped) before switching off the disk drive or power controller circuit breaker. If the disk does not spin down after releasing the RUN/STOP switch, contact field service.

2.2.1 Power Controller Circuit Breaker

The power controller circuit breaker controls the ac power to all the ac circuits in the power controller and provides overload protection for the output receptacles. (The 881 power controller in the four-high cabinet has SWITCHED receptacles only.) The power controller circuit breaker must be in the ON position to draw power from any of its ac outlets.

2.2.2 Bus/Off/On Switch (881 Power Controller)

The 881 power controller rear panel contains a three-position Bus/Off/On switch (Figure 2–4.) This switch controls ac power to the nine ac outlets and selects remote operation. When the circuit breaker to the power controller is ON, the following conditions apply: the ac outlets are energized when the Bus/Off/On switch is in the ON position and not energized when the Bus/Off/On switch is in the OFF position.

The BUS position of the Bus/Off/On switch is intended for remote sensing of DIGITAL power control bus instructions. This position requires the use of a remote sensing cable shipped with the power controller. If you don’t have this cable, or your application does not require the use of the DIGITAL power control bus, leave the switch in the ON position.

NOTE
Some power controllers (other than the 881), have a LOCAL/REMOTE switch. This switch only controls the power to ac outlets marked SWITCHED. The REMOTE position is intended for remote sensing of a keyswitch on a CPU cabinet. This feature enables the power controller to be turned on when the CPU is turned on and requires the use of a remote sensing cable.

For more detailed information on the 881 power controller, refer to the 881 Power Controller User Guide (DIGITAL Order Number EK-881PC-UG). Refer to Figure 2–6 for plug designations and information.

NOTE
The three-high, 40-inch cabinet, uses the 874 power controller.
Figure 2-4  Rear Cabinet Power Controls (Four-High)
Figure 2–5  Rear Cabinet Power Controls (Three-High)
POWER CORDS GOING TO POWER CONTROLLER (FROM REAR OF ENCLOSURE)

120V 60Hz
POWER CORD
DEC NO. A-PS-1700083-23

240V 50Hz
POWER CORD
DEC NO. A-PS-1700083-24

120/240V 47-63Hz
10A/6A
POWER CORD
DEC NO. A-PS-1700442-18 OR
A-PS-1700442-19
USED WITH 881 POWER CONTROLLER

PLUGS GOING TO WALL OUTLET (FROM CONTROLLER)

120V 60Hz
30A
1-PHASE
NEMA NO. L5-30P
DEC NO. 12-11193

240V 50Hz
20A
1-PHASE
USED WITH H874B POWER CONTROLLER
NEMA NO. L6-20P
DEC NO. 12-11192

120/208V AC 60Hz
30A
3-PHASE
WYE
USED WITH 881-A AND 881-C
POWER CONTROLLERS
5-WIRE
NEMA NO. L21-30P

220-240/380-415V AC 50Hz
20A OR 16A
3-PHASE
WYE
USED WITH 881-B
POWER CONTROLLERS
5-WIRE, 4-POLE,
IEC 309

Figure 2-6  Electrical Plug Configurations
2.2.3 Disk Drive Circuit Breakers

A circuit breaker, located on the rear panel of each disk drive, controls the ac power to the drive dc power supply, the cooling fans, and the spindle motor. This circuit breaker and the power controller circuit breaker must be in the ON position before the drive will spin up. See Figure 2–4 for four-high (60-inch) cabinets and Figure 2–5 for three-high (40-inch) cabinets.

2.3 DRIVE OPERATION

This section contains operating instructions for the RA82 disk drive. Before operating, the drive must be properly installed and checked out by a qualified field service engineer.

NOTE
Make sure all drive and logic fans are working every time the drive is turned on. These cooling fans must be working to operate this equipment. Refer to Figure 2–4 for four-high cabinets or Figure 2–5 for three-high cabinets and Figure 2–7 for fan locations.

2.3.1 Spin Up

Push the RUN/STOP button (IN position) on the drive front panel to spin up the drive. The RUN indicator lights, and the READY indicator lights as soon as the drive completes the spin-up cycle and passes the initialization tests. If the initialization tests fail, the FAULT light on the operator control panel lights. See Section 2.1.2 to determine the cause of the problem.

CAUTION
To prevent HDA and head damage, never open or close the upper chassis assembly while the drive is operating.

For optimum drive performance, leave the RA82 disk drive on and spinning as much as possible. Do not power off the disk drive unless absolutely necessary.

2.3.2 Spin Down

Release the RUN/STOP switch (OUT position) on the drive front panel to spin down the drive. The READY and the RUN indicators go off when disk rotation stops.

If the disk does not spin down after releasing the RUN/STOP switch, contact field service.

CAUTION
For optimum drive performance, do not power off or spin down the RA82 disk drive unless absolutely necessary.
Figure 2–7  HDA and Drive Details

2.3.3 Drive Power Removal

Spin down the drive, as described above. When the RUN indicator is off, turn off the drive circuit breaker on the back panel (Figure 2–4 or Figure 2–5) and disconnect the cord to the power controller. This removes power to the drive.

CAUTION

_Do not_ use the disk drive or power controller circuit breaker to stop the drive.

Always spin down the disk (spindle completely stopped) before switching off the disk drive or power controller circuit breaker. If the disk does not spin down after releasing the RUN/STOP switch, contact field service.
2.4 CUSTOMER CARE

Inspect the air filter in the chassis assembly monthly and clean, if necessary.

2.4.1 Air Filter Removal

Remove the air filter as follows:

1. While gently pushing the release latch under the operator control panel, pull down the access door on the front bezel of the drive to reveal the air filter. Refer to Figure 2–8.

![Diagram showing air filter removal](CX-1005A)

**Figure 2–8  Air Filter Removal**

**CAUTION**
To prevent damage to the hinge mechanism, do not lean on or place tools near the open access door.

2. Carefully pull the filter material outward until it is free of the bezel.
2.4.2 Cleaning

1. Gently wash the filter in warm water using a mild detergent.
2. Gently rinse with clear water.
3. Allow the filter to completely dry before reinstalling in the drive.

2.4.3 Air Filter Replacement

1. Slide the clean, dry filter into place inside the bezel.
2. Close the access door by swinging it up into the front bezel until the release latch snaps into place. Make sure the access door is secured in place by the release latch. Refer to Figure 2–8.

NOTE
Order a replacement filter under DIGITAL Part Number 74-29721-01.
3

INSTALLING THE RA82 DISK DRIVE

3.1 INTRODUCTION

This chapter provides installation procedures for the RA82 disk drive and includes notable features, specifications, and cable options. This chapter also includes an introduction to drive cabling.

If you have received a four-high cabinet filled with RA82s or if you have received a cabinet as part of a system configuration, then read this entire chapter for installation procedures.

If you are installing an RA82 as an add-on to an existing cabinet, refer to Chapter 4 for a three-high (40 inch) cabinets, and Chapter 5 for four-high (60 inch) cabinets.

If the system to be installed is an SA configuration, you have been directed here by the Storage Array Configuration Guide. Refer to Chapter 6 for installation instructions.

NOTE
Cabinet unpacking instructions are not covered in this document but can be found in the H9646-AH/AJ Cabinet System User Guide (DIGITAL Order Number EK-H9646-UG) included with every four-high cabinet.

3.2 SITE PREPARATION AND PLANNING

A certain amount of preparation and planning is necessary before installing the RA82 disk drive. The following paragraphs discuss some points to consider.

3.2.1 Environmental Considerations

The RA82 disk drive is designed to operate in a business or light industrial environment. Temperature, humidity, and altitude limits must be considered before the drive is installed. Refer to Table 1-1 for environmental specifications.

CAUTION
RA82 disk drives in any storage array must be thermally stabilized in the site environment a minimum of 24 hours before operation. Failure to thermally stabilize the RA82 disk drive could result in damage to the disk drive media or electronics upon powerup.

3.2.2 Cleanliness

The RA82 sealed HDA minimizes the risk of dust particles entering the area where the recording media is located. However, for maximum reliability and optimum performance, operate the equipment in the cleanest environment possible.
3.2.3 Floor Loading
The weight of one four-high cabinet filled with RA82 disk drives is approximately 408 kilograms (850 pounds). The weight of each additional add-on RA82 is approximately 61.2 kilograms (135 pounds).
The four-high cabinet does not place any abnormal stress on a raised computer room floor. However, consider the weight of existing equipment before installing additional cabinets.

3.2.4 Heat Dissipation
The heat dissipation of each RA82 may reach approximately 644 watts (nominal) at 120 V, 60 Hz. Compute approximate cooling requirements for the complete system by multiplying this figure by the number of drives and adding the heat dissipation figures of the other system components. Adjust the total figure to allow for cooling system efficiency.

3.2.5 Power and Safety Precautions
The RA82 does not present any unusual fire or safety hazards to other computer equipment. However, check the ac power wiring in the computer system to determine adequate capacity for future expansion.

WARNING
Hazardous voltages are present inside this equipment. Bodily injury or equipment damage may result from incorrect servicing. Installation and servicing must be performed by a qualified service person.

To prevent damage to equipment and possible personal injury, verify all power sources to make sure they are the exact voltage and frequency required for this equipment.

CAUTION
The RA82 disk drive and power controller must be the same voltage and frequency. For example, a 120 V, 60 Hz drive must have a 120 V, 60 Hz power controller; a 240 V, 50 Hz drive must have a 240 V, 50 Hz power controller.

Figure 3–1 shows the ac plug configurations for the four-high cabinet and the 881 power controller.

3.3 ADJUSTING THE LEVELER FEET
Use the following procedure to adjust the leveler feet after the cabinet has been moved to its final location. See the H9646-AH/AJ Cabinet System User Guide for more detailed instructions.

1. Turn the leveler hex nut downward until the leveler feet make solid contact with the floor (Figure 3–2).
2. Repeat for each of the four leveler feet until the drive cabinet is level and the load is removed from the casters.

CAUTION
Extend the leveler feet far enough to carry the load of the cabinet, allowing the casters to spin freely. If not, damage to the casters may result over an extended period of time.
POWER CORDS GOING TO POWER CONTROLLER (FROM REAR OF ENCLOSURE)

120V 60HZ
POWER CORD
DEC NO. A-PS-1700083-23

240V 50HZ
POWER CORD
DEC NO. A-PS-1700083-24

120/240V 47-63HZ
10A/6A
POWER CORD
DEC NO. A-PS-1700442-18 OR
A-PS-1700442-19
USED WITH 881 POWER CONTROLLER

PLUGS GOING TO WALL OUTLET (FROM CONTROLLER)

120V 60HZ
30A
1-PHASE
NEMA NO. L5-30P
DEC NO. 12-11193

240V 50HZ
20A
1-PHASE
USED WITH H874B POWER CONTROLLER
NEMA NO. L6-20P
DEC NO. 12-11192

120/208V AC 60HZ
30A
3-PHASE
WYE
USED WITH 881-A AND 881-C
POWER CONTROLLERS
5-WIRE
NEMA NO. L21-30P

220-240/380-415V AC 50HZ
20A OR 16A
3-PHASE
WYE
USED WITH 881-B
POWER CONTROLLERS
5-WIRE, 4-POLE,
IEC 309

CX–1872A

Figure 3–1 Power Connector Configurations
3.6 CABINET INTERLOCK (If Applicable)

The cabinet interlock and the drive actuator assemblies maintain cabinet stability and ensure operator safety. If the stabilizer foot is retracted, all drives are locked and cannot be extended on the slides. When the stabilizer foot is extended, the cabinet interlock mechanism allows only one drive at a time to be extended.

The drive actuator assembly works in conjunction with the cabinet interlock mechanism to maintain cabinet stability. Refer to Figure 3–5.
Figure 3–5 RA82 Actuator Assembly

3.7 EXTENDING AND RETRACTING THE DRIVE ON SLIDES

The following sections describe the procedure for extending and retracting disk drives on the cabinet slides.

CAUTION
To prevent damage to HDA or heads, never extend or retract the cabinet slides while a disk drive is operating. Spin down and completely stop the drive before moving it on the cabinet slides.

3.7.1 Extending the RA82 Disk Drive Using the Slides

Perform the following steps to extend the RA82 disk drive.

1. Pull out the cabinet stabilizer. Refer to Section 3.4.
2. Remove the back door of the cabinet. Refer to Section 3.5.
3. Remove the screws that hold the back of the disk drive to the electrostatic discharge (ESD) brackets. Refer to Figure 3–6.
4. Pull the drive out until the slides lock in place. Refer to Figure 3–7.
Figure 3–8 Connecting ESD Wrist Strap to Ground

2. Extend a drive out of the cabinet on its slides (Section 3.7).

For all drives:

1. Unlock the upper chassis assembly by turning the two cam latches under the front bezel 180 degrees counterclockwise with a 5/16-inch allen hex wrench. Refer to Figure 3–9.

2. Raise the upper chassis assembly until the damper (gas spring) lock slides in place and the cover is supported by the damper (Figure 3–10).

**CAUTION**

To prevent HDA and head damage, never open or close the upper chassis assembly while the drive is operating.

3. Locate the three red shipping brackets that fasten the HDA to its mountings. Refer to Figure 3–11.
Figure 3-9  Upper Chassis Assembly
Figure 3–12  HDA Details

7. Firmly tighten all four HDA retaining nuts with a 7/16-inch nut driver. Refer to Figure 3–12.

8. Ensure the cable spring assembly is in the ENGAGED position as shown in Figure 3–13.

   NOTE
   An interlock switch prevents the spindle motor from operating while the cable spring assembly tension is released. The cable spring assembly must be in the ENGAGED position for spinup.

9. Remove the positioner lock seal and place the positioner lock lever on the HDA in the UNLOCK position (Figure 3–11).
Figure 3–13  Cable Spring Assembly

10. Unlock the logic access cover by manually turning the two captive fastener assembly screws several turns counterclockwise. Release and tighten these screws by hand only. Refer to Figure 3–14.

11. Fold out the logic access cover.
12. Check all modules, cables, and connections. Make sure all cable connectors are firmly seated in the mating connectors.

**NOTE**
Visually inspect all modules and components for obvious damage. Do not operate equipment if components are damaged. Report all damage to the DIGITAL field service or sales office and to the delivery agent.

13. Return the logic access cover to its original closed position. Lock the two captive fastener assembly screws by manually turning them clockwise. Make sure the logic access cover is securely locked in place. Refer to Figure 3-14.

14. Position the read/write cable between the ribs on the HDA to ensure that the cable is not pinched when the cover is closed. Refer to Figure 3-12.

**CAUTION**
Do not pinch cables when lowering the upper chassis assembly. Check cable locations and reroute cables, if necessary, before lowering.

15. Gently lift up on the upper chassis assembly to take the weight off of the gas spring. Unlock the gas spring by pulling the locking knob out while still supporting the weight of the upper chassis assembly. Refer to Figure 3-10.

16. Slowly lower the upper chassis assembly until resistance from the gas spring is felt. When resistance is sufficient to ensure the gas spring will allow the logic to close slowly, release your hold on the upper chassis assembly. Lock in place by turning the two cam latches under the front bezel 180 degrees clockwise with a 5/16-inch allen hex wrench. Refer to Figure 3-9.

**CAUTION**
**DO NOT** permit the upper chassis to free fall and **DO NOT** force the upper chassis assembly against the gas spring pressure.

For drives mounted in a cabinet:
1. Slide the drive back into the cabinet. Refer to Section 3.7.
2. Repeat the above procedures for all drives in the cabinet.

### 3.9 SDI CABLES (DESCRIPTION)

A four-high cabinet subsystem consists of an SDI (Standard Disk Interconnect) disk controller and four RA82 disk drives. Like all RA-series disk drives, the RA82 is connected directly to the disk controller via an external SDI cable. If the RA drive is operated in dual port mode, then two SDI cables are used: one to each disk controller.

These external SDI cables plug into the I/O bulkhead assembly at the rear base of the cabinet. External SDI cables must be installed for each drive in the cabinet between the I/O bulkhead in the CPU or controller cabinet and, in the four-high cabinet, the SDI interface bracket (Figure 3-15). The controller connector should already be installed. If not, refer to the installation procedure in the appropriate disk drive controller user guide.

**NOTE**
In the four-high cabinet, external SDI cables are connected to the inside of the SDI interface bracket. The internal SDI cables exit from the back of the drive and connect to the outside of the SDI interface bracket (Figure 3-15).
Figure 3–14 Opening the Logic Access Cover
Figure 3-15  I/O Bulkhead Mounting

Each drive is shipped with a 12-foot SDI cable for external connection to the drive controller. A second 12-foot SDI cable is required for dual-port operation. In situations requiring more distance between the drive cabinet and the disk controller, other SDI cable lengths are available as shown in Table 3-1.

Table 3-1  SDI Cable Options

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BC26V-6D</td>
<td>Six foot four inch SDI cable</td>
</tr>
<tr>
<td>BC26V-12</td>
<td>Twelve foot SDI cable</td>
</tr>
<tr>
<td>BC26V-25</td>
<td>Twenty-five foot SDI cable</td>
</tr>
<tr>
<td>BC26V-50</td>
<td>Fifty foot SDI cable</td>
</tr>
<tr>
<td>BC26V-80</td>
<td>Eighty foot SDI cable</td>
</tr>
</tbody>
</table>

Use the following procedure to install the external SDI cables to the drive cabinet. For internal SDI cabling information, add-on drive information, and associated cabling, refer to Chapter 4 for three high cabinets and Chapter 5 for four high cabinets.
3.10 EXTERNAL SDI CABLELING PROCEDURE (FOUR-HIGH CABINET)

Refer to Figure 3–15 during the following installation procedure.

1. Remove the rear door of the cabinet (Section 3.5).

2. Plug the external SDI cable from the disk controller into the port A connector on the I/O bulkhead. Note the orientation key on the SDI cable.

   NOTE
   To orient the connections properly for external and internal cables, turn the I/O bulkheads on the left side of the SDI interface bracket 180 degrees from those on the right side. This should be apparent when the screw holes are aligned.

3. If a second disk controller is used, mount its SDI cable into the port B connector on the I/O bulkhead. Note the orientation key on the SDI cable.

   CAUTION
   Ensure no pins are bent during assembly.

4. Tighten the two captive screws on the SDI cable shield terminators to the I/O bulkhead. Do not over tighten (10 inch-pound maximum).

5. Repeat the above cabling procedure for all drives in the cabinet.

6. Reinstall the rear door of the cabinet (Section 3.5).

3.11 SEQUENCE CABLES (DESCRIPTION)

Drive sequence cables are installed to guarantee only one RA82 disk drive at a time starts a spin-up cycle. Sequence cables are used on drives with nonremovable media such as the RA8X-series disk drives (RA80, RA81, and RA82).

The drive sequence cables inside the cabinet connect the drives in a series chain. These cables may also be external to the disk cabinet to connect the series chain in one cabinet with another in a second cabinet. When a large distance exists between drive cabinets, longer lengths of drive sequence cables may be required. Refer to Table 3–2 for a list of these optional lengths.

   CAUTION
   Sequence cables must be installed or disk/data corruption or damage may result during or after a system power failure.
3.12 PROGRAMMING THE UNIT ADDRESS PLUG

The READY switch cap on the operator control panel is also the drive unit address plug. A drive unit number between 0 and 254 (decimal) must be programmed into this plug.

A new switch cover is set as unit 0. To set a drive unit number other than 0, remove the READY switch cap from the control panel and cut off the tabs that add up to the required number. Add the tabs according to the binary values shown in Figure 3–16. For example, if unit number 7 is required for a specific drive, cut tabs 1, 2, and 4 off the switch cap. If unit number 113 is required, remove tabs 64, 32, 16, and 1. Leave all tabs on if unit number 0 is required.

NOTE
Do not use the same unit number for two drives on the same controller.

After selecting the drive unit number, place the gummed label with the corresponding number in the recessed area on the front of the switch cap. Then replace the switch cap on the operator control panel. For more information on the READY plug and indicator, see Section 2.1.3.

3.13 RA82 DRIVE DIAGNOSTIC CHECKOUT

The following paragraphs describe how to run the RA82 drive-resident diagnostics using the diagnostic terminal and how to verify the proper operation of each RA82 disk drive after installation.

NOTE
RA82 disk drive checkout must be performed by trained field service personnel only.
3.13.1 The Diagnostic Terminal

A field service hand-held diagnostic terminal used to communicate with the RA82 is stocked with every spares kit. The diagnostic terminal uses a standard ASCII keyboard and an RS232 interface. The RS232 connector for the diagnostic terminal is located inside of the front bezel filter door.

Instructions on how to use the hand-held terminal are in the *DSA Hand Held Terminal User Guide* (DIGITAL Order Number EK-DSAHH-UG). Any EIA-compatible terminal (with null modem cable) set at 300 baud can be used to communicate with the drive to run the diagnostic tests.

3.13.2 Applying Power to the Drive

Use the following procedure to apply power to the RA82 disk drive.

**CAUTION**

RA82 disk drives in any storage array must be thermally stabilized a minimum of 24 hours in the site environment before operation. Failure to thermally stabilize the RA82 could result in damage to the disk drive media or electronics upon powerup.

1. Verify the ac circuit breakers on the power control unit and each disk drive are in the OFF position. Refer to Figure 3–17 for four high (60 inch) cabinets or Figure 3–18 for three high (40 inch) cabinets.

2. Plug the disk drive power cord between the drive and the power controller into the receptacle on the power control unit at the bottom of the cabinet.

**WARNING**

The power cord between the drive and the power controller (disk drive power cord) in the four-high cabinet is the same for both 120 V, 60 Hz and 240 V, 50 Hz. To prevent damage to equipment and possible personal injury, verify both the disk drive and the power controller in the four-high cabinet are the same voltage and
frequency. A 120 V, 60 Hz drive must have a 120 V, 60 Hz power controller; a 240 V, 50 Hz drive must have a 240 V, 50 Hz power controller.

3. Switch the ac circuit breaker on the power control unit to the ON position. Refer to Figure 3-17 for four high (60 inch) cabinets or Figure 3-18 for three high (40 inch) cabinets.

3.13.3 Verifying RA82 Disk Drive Operation

Use the following procedure to verify disk drive operation.

CAUTION
For drive protection, use a grounded (electrostatic discharge) wrist strap during the following procedures (Figure 3-8). Also, read Section 1.7 for information on ESD protection.

1. Unlock the upper disk drive chassis assembly by turning the two cam latches under the front bezel 180 degrees counterclockwise with a 3/16-inch allen hex wrench. Refer to Figure 3-9.

2. Raise the upper chassis assembly until the damper lock slides in place and the chassis is supported by the damper (Figure 3-10).

3. Unlock the logic access cover by manually turning the two captive fastener assembly screws several turns counterclockwise. (Release and tighten these screws by hand only.) Refer to Figure 3-14.

4. Fold out the logic access cover (Figure 3-14).

5. Check that all module and cable connectors are firmly seated. Also, visually inspect all modules and components for obvious damage. Do not operate equipment if components are damaged.

6. Switch the ac circuit breaker on the back of the disk drive to the ON (up) position. This activates the internal disk drive diagnostics (hardcore test sequence) and all front panel indicator lights. When the drive successfully passes the diagnostics, the front panel lights will go off (3 or 4 seconds).

CAUTION
Make sure the drive and logic fans are working every time the drive is turned on. These cooling fans must be working to operate this equipment. Refer to Figure 3-17 for four high (60 inch) cabinets or Figure 3-18 for three high (40 inch) cabinets, and Figure 3-12 for fan locations.

If an error occurs, press and release the FAULT switch/indicator on the operator control panel to display the drive condition fault codes indicated by fault lights on the front panel. See Section 2.1.2 for additional information on the FAULT switch and indicator.

7. As a front panel lamp test, depress and hold the FAULT switch of the RA82 OCP after the hardcore test sequence. All front panel lights should light.

NOTE
If both port select switches (A and B) are placed in the OUT position while the READY indicator is on, the READY indicator goes off. The drive automatically goes into an internal idle loop test sequence any time both port switches are out. During this time, the drive is not ready, and the indicator goes on and off intermittently while this self test is being executed.

Both port select switches must be OUT to run internal drive diagnostics.
Figure 3–17 Rear Cabinet Power Controls (60-Inch Cabinets)
Figure 3-19  Hinged Circuit Module Arrangement
Figure 3–20  Diagnostic Terminal Connections
Figure 3–21 Locking the Logic Access Cover
Figure 3–22  HDA Removal
4

INSTALLATION OF RA82 DISK DRIVES IN THREE-HIGH CABINETS

4.1 INTRODUCTION

This chapter describes the installation of the RA82 disk drive in the 40-inch (three-high) cabinet system. For a list of basic three-high cabinet specifications, refer to Table 4–1.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall height</td>
<td>41.8 inches (106 cm)</td>
</tr>
<tr>
<td>Depth</td>
<td>36 inches (91.4 cm)</td>
</tr>
<tr>
<td>Width</td>
<td>21.3 in (54.2 cm)</td>
</tr>
<tr>
<td>Weight (empty)</td>
<td>52 lbs (23.5 kg)</td>
</tr>
<tr>
<td>Mounting width</td>
<td>19 inches (48.3 cm)</td>
</tr>
<tr>
<td>Mounting</td>
<td>STD EIA/RETMA</td>
</tr>
<tr>
<td>Cooling</td>
<td>Front to rear</td>
</tr>
<tr>
<td>Frame construction</td>
<td>All steel, riveted</td>
</tr>
<tr>
<td>Power cord length</td>
<td>14 feet</td>
</tr>
</tbody>
</table>

NOTE
For specific information and instructions on drives other than the RA82, refer to the appropriate disk drive user guide and the H9642-JA/JB Installation Sheet, Order Number EK-9642K-IN.

4.2 UNPACKING AND EXTERNAL INSPECTION (40-INCH CABINET)

When delivered, the three-high cabinet containing the RA82 disk drives is packed in a cardboard container attached to a shipping skid or pallet. Refer to Figure 4–1.
Figure 4-1  Unpacking the 40-Inch Cabinet System
4.2.1 Unpacking the System on a Shipping Pallet

Use the following procedure to unpack and remove the equipment from the pallet. Use Figure 4–1 as a guide.

1. Cut the shipping straps with diagonal cutters.
2. Lift and remove the cover.
3. Remove the two unloading ramps packed in the box on top of the disk cabinet.
4. Remove the shipping carton and all associated packing materials.
5. Check the cabinet and associated equipment for any external shipping damage. Report any damage to the DIGITAL field service or sales office and to the local carrier.

NOTE
Keep all packing material and receipts in case a damage claim is filed.

6. Remove the four shipping bolts that fasten the drive cabinet to the pallet. Refer to the inset in Figure 4–1.
7. Slide the four shipping brackets off the cabinet leveler feet.
8. Extend the loading ramps to their full length by connecting the two sections of each ramp with the steel dowel (taped to the ramp). Refer to Figure 4–2.
9. Matching the arrows, attach the two unloading ramps to the pallet by fitting the tab of each ramp board into the pre-drilled holes on the rear of the pallet deck (Figure 4–2).
10. Screw the cabinet leveler feet all the way up into the chassis by turning the lock nut down until it makes contact with the leveler hex nut, and then turning the hex nut up until it raises the leveler foot. The cabinet should now rest on the casters so that the leveler feet will not touch the ramps (Figure 4–3).

CAUTION
Fully retract the leveler feet to prevent contact with the floor when the cabinet is unloaded from the skid.

WARNING
Take extreme care during the following procedures. At least two people (preferably three) must assist in the process of deskidding or taking the cabinet off the pallet.

The cabinet is top-heavy. Restrain it when you roll it from pallet onto the ramp. When rolling it down the ramp, guide it and retard its motion.

11. Carefully roll the drive cabinet down the ramps.
12. Wheel the cabinet to its final location.
13. Adjust the leveler feet downward until they make solid contact with the floor. Adjust the four leveler feet until the drive cabinet is level and stable. See Figure 4–3.

4.2.2 Removing the Internal Shipping Brackets and Packing Material

Remove the packing materials and shipping brackets inside the chassis of each disk drive using the procedures described in Section 3.8.
4.2.3 Electrostatic Discharge (ESD) Brackets

The electrostatic discharge (ESD) brackets ground the disk drive to the cabinet.

CAUTION
This ESD ground connection must always be made before the drive is operated.

Use the following procedure and Figure 4-4 to secure the drives to the ESD brackets:

1. Locate the ESD bracket holes on the rear of the drive.

2. Push the drive forward just enough to remove the bottom corner 1/4-inch hex screws and washers on the power supply.

3. Use the screws and washers just removed to secure the drive to the two ESD brackets.

The screws holding the ESD brackets must be removed to slide the drive forward. These brackets must be reconnected each time the drive is pushed back into the cabinet.
4.3 OPENING AND REMOVING THE REAR DOOR

Refer to Figure 4–5 and Figure 4–6 when performing these procedures.

Open the rear door:
1. Turn the hex lock counterclockwise.
2. Pull open the rear door.

Remove the rear door:
1. Open the rear door as described above.
2. Remove the ground wire attached to the bottom inside of the door.
3. Pull down on the latch in the top corner and lift the door off the lower bracket.

4.4 CABLELING THE RA82 TOP DRIVE

Before proceeding with the cabling, open and remove the rear door of the cabinet as described in Section 4.3.
Figure 4–4  Electrostatic Discharge Bracket Details

4.4.1 Mounting the I/O Bulkhead Connectors

An I/O bulkhead connector must be installed on the SDI interface bracket at the back of the drive cabinet for each add-on drive. Screw this assembly to the SDI interface bracket as shown in Figure 4–7.

4.4.2 Installing External SDI Cables

The external SDI cables coming from the central processing unit (CPU) are connected to the I/O bulkhead assembly. Refer to Figure 4–7 and Figure 4–8 for cabling of the top drive.
Figure 4-5  Opening the Rear Door
Figure 4-6  Removing the Rear Door
Figure 4–7  I/O Bulkhead
Figure 4-8  SDI Cables for the Top Drive
The external SDI cables must be installed between the I/O bulkhead in the CPU or controller cabinet and all drive I/O bulkhead connectors in the drive cabinet. The controller connector should already be installed. If not, refer to the appropriate controller user guide for instructions on installing the SDI cables at the controller. Use the following procedure to install the external SDI cables to the drive cabinet.

1. Unscrew the two screws holding the I/O bulkhead connector to the SDI interface bracket.
2. Remove the I/O bulkhead connector.
3. Plug the external SDI cable from the disk controller into port A connector on the I/O bulkhead. Note the orientation key on the SDI cable. Refer to Figure 4–7 and Figure 4–8.
4. If a second disk controller is used, mount its SDI cable into port B of the I/O bulkhead connector. Note the orientation key on the SDI cable.

**CAUTION**
Ensure that no pins are bent during assembly.

5. Tighten the two captive screws on the SDI cable shield terminators to the I/O bulkhead connector. *Do not overtighten (10 in/lb maximum.)*
6. Reconnect the I/O bulkhead connector to the SDI interface bracket.
7. Tighten the two captive screws on the I/O bulkhead connector. *Do not overtighten (10 in/lb maximum.)*
8. Repeat the above cabling procedure for all drives in the cabinet.

**NOTE**
If more than one drive is mounted in the cabinet, additional cables must be installed. Refer to Section 4.5 for instructions.

### 4.4.3 Installing Internal SDI Cables

The two internal SDI cables that exit from the back of the drive connect to the I/O bulkhead connector (Figure 4–7). Use the following procedure to install the internal SDI cables to the top drive:

1. Locate the port A SDI cable where it exits at the back of the disk drive. Plug the end of the port A connector into the port A position on the I/O bulkhead connector. Note the orientation key on the SDI cable.

**CAUTION**
Ensure that no pins are bent during assembly.

2. Tighten the two captive screws on the SDI cable shield terminator to the I/O bulkhead connector. *Do not overtighten 10 in/lb maximum.)*
3. Repeat steps 1 and 2 for the port B internal SDI cable.
4. Secure the SDI cables as indicated in Figure 4–8.
Figure 4-10  Rear Cabinet Power Controls (40-Inch Cabinet)
Figure 4–11  Power Cord Routing on Cab Floor

4.5.2 Removing the Front Filler Panels

Remove the middle panel from the front of the drive cabinet if this is the first add-on drive to be installed. Remove the bottom panel from the front of the drive cabinet if this is the second add-on drive. The front cabinet panels are held to the cabinet uprights by four nuts and washers. Refer to Figure 4–12.

4.5.3 Extending the Cabinet Stabilizer Foot

Extend the stabilizer foot forward from the center bottom of the drive cabinet and lower the foot so that it makes firm contact with the floor. This step is very important. It prevents the drive cabinet from tipping forward when the new drive is added. Refer to Figure 4–13.

WARNING
Always extend the cabinet stabilizer foot forward before sliding a drive out of the cabinet for any reason. Failure to do so could cause equipment damage or bodily injury.
4.6 PREPARING THE ADD-ON DRIVE FOR INSTALLATION

The first and second add-on drives in a 40-inch (three-high) cabinet must be mounted on a slide assembly. The top drive in a 40-inch cabinet is not mounted on slides.

Use the following procedures to prepare the add-on drive for installation.

WARNING
Since the drive weighs at least 61.2 Kg (135 pounds), you must use an approved field service lifting device rated at 200 pounds (DIGITAL Part Number FC-10074-AC) to place the drive onto the chassis slides.

If an approved lifting device is not available, at least three persons are required to lift and install the disk drive. (Refer to Section 4.8.2 for the appropriate procedure.)

The head disk assembly (HDA) may be removed from the drive to reduce the total weight by approximately 35 pounds. Refer to Section 5.6 for instructions on HDA removal.
Figure 4–13  Extending the Stabilizer Foot

4.6.1 Removing Internal Shipping Brackets and Packing Material

Packing materials and shipping brackets are inside the chassis of each disk drive. To remove them, follow the procedures described in Section 3.8.

4.7 INSTALLING CABINET SLIDES

Drives must be mounted on a slide assembly. Refer to Figure 4–14 and Figure 4–15 for the proper installation hole locations in the 40-inch (three-high) cabinet.

Note that in the 40-inch cabinet the first hole in the rear uprights above the power controller is hole number 7. On the front of the 40-inch cabinet, if the lower front panel is still in place, the next hole in the cabinet uprights above the front panel is hole number 25.
Figure 4–14  Cabinet Upright Holes (40-Inch Cabinet)

4.7.1 Preparing the Slides for Cabinet Mounting

Use the following procedure to prepare the cabinet slide assemblies for installation. Assemble the left-hand slide assembly first.

1. Locate the left-hand slide that has part number 1213686-00-REV-X-L engraved on it. The revision level of the slide is given here as "X" because it changes occasionally. The letter L indicates this is the left-hand slide.

2. Locate the plastic bag containing four slide brackets.

3. Locate the plastic bag containing the 8-32 X 5/16 screws.

4. Lay the left-hand slide on its back and push the lower half of the slide to the left to gain access to the rear mounting holes (Figure 4–16).

5. Use two 8-32 screws to mount the rear slide bracket to the slide as shown in Figure 4–16. Don’t tighten the screws all the way since some leeway is needed later when the slides are mounted into the cabinet.

6. Use two more 8-32 screws to mount the front slide bracket to the left-hand slide. The screws must be inserted into the mounting holes through the movable oval opening on the slide. Tighten the two screws.
Figure 4–15 Mounting Hole Table

7. Press the two front leaves of the L-shaped cable retainer together and force the retainer into the rear of the left-hand slide assembly as shown in Figure 4–16.

NOTE
A cable retainer must be used on each left-hand slide assembly for drives installed in positions 0, 1, and 2.

8. Locate the drive right-hand slide that has part number 1213686-00-REV-X-R engraved on it. The revision level of the slide is given as "X" because it changes occasionally. The letter R indicates this is the right-hand slide.

9. Lay the right-hand slide on its back and push the lower half of the slide to the right to gain access to the rear mounting holes (Figure 4–17).
10. Use two 8-32 screws to mount the rear slide bracket to the slide. Don't tighten the screws all the way since some leeway is needed when the slides are later mounted into the cabinet.

11. Use two more 8-32 screws to mount the front slide bracket to the right-hand slide. Insert the screws into the slide mounting holes by aligning the oval opening over them. Tighten the two screws.

Both slides are now prepared for installation into the drive cabinet.

4.7.2 Attaching Slides to Cabinet

Use the following procedures to install the slides and associated hardware in the cabinet.

1. Go to the rear of the drive cabinet. Counting from the bottom, locate and mark the mounting holes in both rear cabinet uprights. Refer to Figure 4–14.

2. Go to the front of the drive cabinet. Counting from the bottom, locate and mark the mounting holes on both front cabinet uprights. Refer to Figure 4–14.

3. Locate the plastic bag containing the 10-32 X 1/2 screws.

4. Locate the plastic bag containing the four nut bars.

5. Locate the plastic bag containing two electrostatic discharge (ESD) brackets.

6. At the front of the cabinet, mount the right-hand slide assembly to the front-right cabinet upright using two 10-32 screws and one nut bar as shown in Figure 4–18.

7. Use the same procedure to mount the left-hand slide assembly to the front-left cabinet upright.

8. Go to the rear of the cabinet. Insert one 10-32 screw through the left-hand cabinet upright, the top hole of the right-hand slide bracket, and the top hole of the nut bar (to hold the slide in place).

9. Use two more 10-32 screws to mount the ESD bracket to the upright as shown in Figure 4–18.

10. Use the same procedure to mount the left-hand slide assembly and ESD bracket to the rear-right hand cabinet upright.

11. Once both slides are mounted, go to the rear of the cabinet and tighten the screws holding the slides to the slide brackets. These brackets were left loose for adjustment. Do this for both slides.

4.8 MOUNTING THE ADD-ON DRIVE ON THE SLIDES

Use the following procedure to mount the RA82 add-on drive on the slides. Refer to Figure 4–19.

WARNING
The cabinet stabilizer foot must be fully extended and locked (Figure 4–13).

The RA82 disk drive weighs at least 61.2 Kg (135 pounds). DIGITAL recommends that you use an approved field service lifting device rated at 200 pounds (DIGITAL Part Number FC-10074-AC) to place the drive on the chassis slides.
Figure 4–16 Left-Hand Slide
Figure 4–17  Right-Hand Slide
Figure 4–18 Mounting the Slide Assembly
2. Place one person on each side of the unit.
3. Place one person at the front of the unit.
4. The two persons at the sides of the unit grasp the front and rear of the unit and, using the leg muscles, lift the unit together.
5. The person at the front of the unit removes the skid or other packaging material from the immediate area.
6. The person at the front of the unit guides the lifters and assures that the slides are locked and that the unit is resting on the slides correctly.
7. While the two are holding the RA82 in position, the third person starts two mounting screws on each side of the unit (the one closest to the front and the one closest to the rear).
8. Secure the remaining mounting hardware as required and continue with normal installation procedures.

4.9 INSTALLING CABLE STANDOFFS AND U-NUTS

Cable standoffs and U-nuts are used with cable clamps in the three-high cabinet to hold the cables away from the rear vertical uprights. The number of cable standoffs to install depends upon the number of drives in the cabinet. Refer to Figure 4–15 for the proper three-high RA82 cabinet installation holes.

Use the following procedure to mount each cable standoff and U-nut. Refer to Figure 4–20.

1. Locate the plastic bags containing the cable standoffs.
2. Locate the plastic bag containing the U-nuts.
3. Slide each U-nut over the hole of the rear vertical upright designated in Figure 4–15. The threaded portion of the U-nut should face the inside of the cabinet.
4. Screw the standoff into the U-nut.

4.10 INSTALLING THE I/O BULKHEAD CONNECTORS

Locate the I/O bulkhead connector that came with the add-on disk drive. Based on drive position, each I/O bulkhead must be mounted in a designated location on the SDI interface bracket. Using the two captive screws, mount the I/O bulkhead to the SDI interface bracket at the rear base of the drive cabinet as shown in Figure 4–7.

4.11 INSTALLING SDI CABLES

Two six-foot SDI cables and one twelve-foot SDI cable are shipped with each add-on drive. The two six foot SDI cables are the internal cabinet cables that connect the drive to the I/O bulkhead assembly. The twelve-foot SDI cable is the external cable that attaches the drive cabinet to the disk controller in another cabinet.

When installing the SDI cables, you have to choose which of the following SDI cable installation procedures fits your need. The first one describes how to install the SDI cables for the first RA8X series add-on (middle cabinet position). The second one describes how to install the SDI cables for the second RA8X series add-on (bottom cabinet position).
4.11.1 Installing the First Add-On Drive SDI Cables

Use the following procedure to install the SDI cables for the first add-on drive. Refer to Figure 4–21. See Figure 4–22 for electrical wiring diagrams of a two-drive system.

1. Install the bottom end of the SDI cables with the I/O bulkhead on the SDI interface bracket at the base of the cabinet.

2. Clamp the SDI cables to the cable retainers on the end of the drive slides and the cable standoffs.

3. Starting at the I/O bulkhead, tie wrap the SDI cables as shown in Figure 4–21. Leave enough slack in the SDI cables so the drive can slide out the front of the cabinet.
4.11.2 Installing the Second Add-On Drive SDI Cables

Use the following procedure to install the SDI cables for the second add-on drive. Refer to Figure 4–23. See Figure 4–24 for cable wiring diagrams of a three- and four-drive system.

1. Install the bottom end of the SDI cables from the second add-on drive into the I/O bulkhead assembly at the base of the cabinet. Based on drive position, each I/O bulkhead must be mounted in a designated location on the SDI interface bracket. Using the two captive screws, mount the I/O bulkhead to the SDI interface bracket at the rear base of the drive cabinet as shown in Figure 4–7.

2. Clamp the SDI cables to the cable retainers on the end of the drive slides and the cable standoffs.

3. Tie wrap the SDI cables as shown in Figure 4–23.

4. Extend the cabinet stabilizer foot and pull the drive out of the cabinet to check if there is enough slack left in the SDI cables. Check that no cables are being pinched. If necessary, adjust the cable loop.

This completes the SDI cable installation for the second add-on drive. The sequence cables are added next.

4.12 INSTALLING SEQUENCE CABLES ON RA8X DISK DRIVES

Sequence cables permit only one drive to start up at a time. All RA8X series disk drives need drive sequence cables. RA60 disk drives do not use drive sequence cables because they do not require as much start-up current. The following drive sequence cable procedures assume that only RA8Xs are used in the cabinet.

**CAUTION**
Sequence cables *must* be installed or disk/data corruption or damage may result during or after a system power failure.

4.12.1 Installing First Add-On Drive Sequence Cables

Use the following procedure to install the drive sequence cables on the first RA8X series add-on drive. Refer to Figure 4–21. See Figure 4–22 for electrical wiring diagrams of a two-drive system.

1. Install a sequence cable between the OUT connector on the back of the top drive and the IN connector on the back of the first add-on drive.

2. Tie wrap the sequence cables to the SDI cables as shown in Figure 4–21 leaving enough slack in the cables so the drive can be slid out the front of the cabinet.

3. Extend the cabinet stabilizer foot and then pull the add-on drive out of the cabinet to check if you left enough slack in the sequence cables. Check that no cables are being pinched. Adjust cables if necessary.

4. Use as many tie wraps as needed to dress the cables properly.
Figure 4-23  Cable Routing - Second Add-On Drive
Figure 4–24  Cable Wiring Diagram of a Three- or Four-Drive System (Generic)
4.12.2 Installing the Second Add-On Drive Sequence Cables

Use the following procedure to install the sequence cables onto the second RA8X series add-on drive. This procedure assumes that the top and middle drives are RA8X series drives. Refer to Figure 4–23. See Figure 4–24 for electrical wiring diagrams of a three- and four-drive system.

1. Install a sequence cable between the OUT connector on the back of the top drive and the IN connector on the back of the first add-on drive.

2. Install a second sequence cable between the OUT connector on the back of the first add-on drive and the IN connector on the back of the second add-on drive.

3. Tie wrap these sequence cables to the SDI cables as shown in Figure 4–23 leaving enough slack so the drives can be slid out the front of the cabinet.

4. Extend the cabinet stabilizer foot and pull the add-on drives out of the cabinet to check if there is enough slack in the sequence cables. Check that no cables are being pinched. Adjust cables if necessary.

5. Use as many tie wraps as needed to dress the cables properly.

4.13 INSTALLING THE SEQUENCE TERMINATOR PLUG

Check to see if there is a drive sequence terminator plug at the IN connector of the first drive. If not, use the terminator plug (Part Number 70-19692-01) that comes in the add-on RA8X series drive hardware kit.

4.14 INSTALLING THE DISK DRIVE POWER CORDS

The installation of the disk drive power cord varies depending on whether you are installing the first or second add-on drive. In general, disk drive power cords are routed with the SDI cables down the rear cabinet upright to the power controller. The power cords are then routed through the grommeted opening in the power controller.

4.14.1 Installing the First Add-On Drive Power Cord

Use the following procedure to install the disk drive power cord for the first RA82 add-on drive. Refer to Figure 4–21. See Figure 4–22 for electrical wiring diagrams of a two-drive system.

1. Plug the disk drive power cord into the rear of the top drive in the cabinet.

2. Plug the disk drive power cord into the rear of the first add-on drive.

3. Secure the power cords as shown in Figure 4–21.

4. Extend the cabinet stabilizer foot and then test whether enough slack has been left in the power cord on the add-on drive by sliding the drive all the way forward. Leave enough slack so there isn’t any tension on the power cord when the drive is extended. Loosen the power cord at the standoff cable clamp if necessary.

5. Insert the plug ends of the power cords through the grommeted opening in the power controller panel at the base of the cabinet.

6. Route the power cords over the base of the cabinet as shown in Figure 4–11.

7. Plug the shortest power cord into power controller receptacle J6.

8. Plug the power cord from the add-on drive into power controller receptacle J5.
9. After the power cords are routed properly on the base of the cabinet, secure them in place with tie wraps. Slide the tie wraps with their rough side up through the plastic cable mounts on the floor of the cabinet. Tighten the tie wraps around the power cords. Cut off the excess tie wrap material.

4.14.2 Installing the Second Add-On Drive Power Cord

Use the following procedure to install the disk drive power cord on the second add-on drive. Refer to Figure 4–23. See Figure 4–24 for cable wiring diagrams of a three- and four-drive system.

1. Plug the disk drive power cords into the rear of the drives.
2. Secure the power cords as shown in Figure 4–23.
3. Extend the cabinet stabilizer foot, then slide the bottom disk drive all the way out of the cabinet to test whether there is enough slack in the power cord. Check to make sure that no cables are being pinched. Adjust the power cord loops, if necessary.
4. Insert all three power cords through the grommeted opening in the power controller panel.
5. Route the power cords over the base of the cabinet as shown in Figure 4–11.
6. Plug the shortest power cord into power controller receptacle J6.
7. Plug the power cord from the first add-on drive into power controller receptacle J5.
8. Plug the power cord from the second add-on drive into power controller receptacle J4.
9. After the power cords are routed properly on the base of the cabinet, tie wrap them in place. Slide the tie wraps with their rough side up through the plastic cable mounts on the floor of the cabinet. Tighten the tie wraps around the power cords. Cut off excess tie wrap material.

4.15 REMOVING HDA SHIPPING BRACKETS

If you removed the HDA for installation, refer to Section 5.19 for the replacement procedure. Remove the shipping brackets from the HDA now if this was not done when you mounted the add-on drive onto the slides. Use the procedure described in Section 3.8.

4.16 SECURING THE DRIVE TO THE ESD BRACKETS

Secure the drive to the ESD brackets as described in Section 4.2.3

4.17 PERFORMING DRIVE CHECK-OUT PROCEDURE

After installing the add-on drive, perform the drive check-out procedure described in Section 3.13.

4.18 REMOVING A DRIVE

This section describes how to remove an RA82 disk drive from a three-high cabinet.
4.18.1 Removing Power

Before reconfiguring a cabinet, remove the power from the system by tripping the circuit breaker on the power controller. The power controller is located on the bottom of the cabinet. The circuit breakers are located at the rear of the power controller.

4.18.2 Removing Sequence Cables (From Mounted Drives)

The sequence cables are the small, round gray cables. As the sequence cables travel down the rear of the cabinet, they are held in place by a number of tie wraps. Cut away all the tie wraps that hold the sequence cables in place. (Don’t cut the cable clamps that hold the SDI cables.) Then unplug the sequence cables from the rear of the drive(s). Refer to Figure 4–25.

4.18.3 Removing the Power Cord (From Mounted Drives )

Use the following procedure to remove the disk drive power cord from the top drive or drives.

1. Cut away the three tie wraps that hold the power cord to the inside floor of the cabinet (Figure 4–11).

2. Remove and save the two cable clamps that hold the power cord to the rear cabinet upright. Leave the two standoffs attached to the cabinet.

3. Unplug the power cords from the power controller in the base of the cabinet.

4. Unplug the power cord from the back of the top disk drive only if it is an RA8X series drive.

5. Remove the power cord from the first add-on drive (middle cabinet position) only if it is an RA8X series drive and you are installing the second add-on drive (in the bottom cabinet position).

6. Pull the power cords out from the grommeted opening in the power controller panel and save them for later reinstallation.
Figure 5–1 Rear Door Removal
Figure 5-2  Front Filler Panel Removal
The head disk assembly (HDA) may be removed from the drive to reduce the total weight by approximately 35 pounds. Refer to Section 5.6 for instructions on HDA removal.

5.5.1 Removing Internal Shipping Brackets and Packing Material

Packing material and shipping brackets are inside the chassis of each disk drive. Use the procedure described in Section 3.8 to remove the brackets and material to prepare the drive for installation.

If you do not need to remove the HDA, follow the procedures beginning in Section 5.7 to install the slides and mount the disk drive into the cabinet.

5.6 REMOVING THE HDA

Use the following procedure to remove the head disk assembly (HDA) from the RA82 disk drive.

CAUTION
For drive protection, use a grounding (electrostatic discharge) wrist strap during the following procedures (Figure 5–3). For information on ESD protection, read Section 1.7.

1. Unlock the upper chassis assembly by turning the two cam latches under the front bezel 180 degrees counterclockwise with a 3/16-inch allen hex wrench. Refer to Figure 5–4.

2. Raise the upper chassis assembly until the damper (gas spring) lock slides in place and supports the upper chassis assembly (Figure 5–5).

3. Unplug connector P502 from the read/write module (Figure 5–6).

4. Unplug connectors P602 and P603 from the HDA preamplifier module (Figure 5–6).

5. Place the cable spring assembly in the RELEASED position (Figure 5–7).

6. Place the positioner lock in the LOCK position (Figure 5–8). The lever must be lifted slightly to clear the surface of the read/write module.

7. Remove the four HDA retaining nuts and washers (Figure 5–6).

CAUTION
The HDA could be damaged if the positioner is not locked.

8. Remove the HDA from the drive by lifting it from diagonally opposite corners (Figure 5–8). The HDA weighs approximately 35 pounds.

9. Place the HDA on a level surface in the vertical position only. Feet are provided on the front cover of the HDA for this purpose (Figure 5–8).

CAUTION
Do not place the HDA in a horizontal position (on the pulley) or the speed and temperature transducers mounted on the bottom of the HDA could be damaged.

If the HDA is to be moved or packed for shipment, use an HDA Spindle Pulley Lock (DIGITAL Order Number 74-31667-01) to lock the spindle pulley in place. Any movement of the spindle could damage the heads.
Figure 5–3  Connecting ESD Wrist Strap to Ground

10. Gently lift up on the upper chassis assembly to take the weight off of the gas spring. Unlock the gas spring by pulling the locking knob out while still supporting the weight of the upper chassis assembly. Refer to Figure 5–5.

11. Slowly lower the upper chassis assembly until resistance from the gas spring is felt. When resistance is sufficient to ensure the gas spring will allow the logic to close slowly, release your hold on the upper chassis assembly. Lock in place by turning the two cam latches under the front bezel 180 degrees clockwise with a 5/16-inch allen hex wrench. Refer to Figure 5–4.

CAUTION

*DO NOT* permit the upper chassis to *free fall* and *DO NOT* force the upper chassis assembly against the gas spring pressure.

CAUTION

Do not pinch cables when lowering the upper chassis assembly. Check cable locations and reroute cables, if necessary, before lowering.
Figure 5–4  Upper Chassis Assembly
Figure 5–5 Damper (Gas Spring) Assembly

5.7 PREPARING THE SLIDES FOR CABINET MOUNTING

Use the following procedure to prepare the cabinet slide assemblies for installation.
Assemble the left-hand slide assembly first.

1. Locate the left-hand slide that has part number 1213686-00-REV-X-L engraved on it. The revision level of the slide is given here as "X" because it changes occasionally. The letter L indicates this is the left-hand slide.

2. Locate the plastic bag containing four slide brackets.

3. Locate the plastic bag containing the 8-32 X 5/16 screws.

4. Lay the left-hand slide on its back and push the lower half of the slide to the left to gain access to the rear mounting holes (Figure 5–9).
Figure 5-6  HDA Connectors

5. Use two 8-32 screws to mount the rear slide bracket to the slide as shown in Figure 5-9. Don’t tighten the screws all the way since some leeway is needed later when the slides are mounted into the cabinet.

6. Use two more 8-32 screws to mount the front slide bracket to the left-hand slide. The screws must be inserted into the mounting holes through the movable oval opening on the slide. Tighten the two screws.

7. Press the two front leaves of the L-shaped cable retainer together and force the retainer into the rear of the left-hand slide assembly as shown in Figure 5-9.

NOTE
A cable retainer must be used on each left-hand slide assembly for drives installed in positions 0, 1, and 2.
Figure 5-7  Cable Spring Assembly
Figure 5-8  HDA Positioner Lock

8. Locate the drive right-hand slide that has part number 1213686-00-REV-X-R engraved on it. The revision level of the slide is given as "X" because it changes occasionally. The letter R indicates this is the right-hand slide.

9. Lay the right-hand slide on its back and push the lower half of the slide to the right to gain access to the rear mounting holes (Figure 5-10).

10. Use two 8-32 screws to mount the rear slide bracket to the slide. Don’t tighten the screws all the way since some leeway is needed when the slides are later mounted into the cabinet.
11. Use two more 8-32 screws to mount the front slide bracket to the right-hand slide. Insert the screws into the slide mounting holes by aligning the oval opening over them. Tighten the two screws.

Both slides are now prepared for installation into the drive cabinet.

5.8 INSTALLING CABINET SLIDES

Use the following procedures to install the slides and associated hardware in the cabinet. Refer to Table 5–3 for the proper four-high RA82 cabinet installation holes.

Table 5–3  RA82 Installation Holes

<table>
<thead>
<tr>
<th>Drive Position</th>
<th>FRONT Slide Holes</th>
<th>REAR Slide Holes</th>
<th>ESD Brackets</th>
<th>RIGHT REAR* Clamp/Standoff</th>
<th>LEFT REAR* Clamp/Standoff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive 3</td>
<td>66, 70</td>
<td>70</td>
<td>67, 69</td>
<td>Not used</td>
<td>71</td>
</tr>
<tr>
<td>Drive 0</td>
<td>48, 52</td>
<td>52</td>
<td>49, 51</td>
<td>53</td>
<td>48</td>
</tr>
<tr>
<td>Drive 1</td>
<td>27, 31</td>
<td>31</td>
<td>28, 30</td>
<td>43</td>
<td>27</td>
</tr>
<tr>
<td>Drive 2</td>
<td>9, 13</td>
<td>13</td>
<td>10, 12</td>
<td>22</td>
<td>9</td>
</tr>
</tbody>
</table>

* RIGHT REAR refers to the right rear vertical upright as viewed from the front of the cabinet. LEFT REAR refers to the left rear vertical upright as viewed from the front of the cabinet.

1. Go to the rear of the drive cabinet. Counting from the bottom, locate and mark the mounting holes in both rear cabinet uprights. Refer to Figure 5–11.

2. Go to the front of the drive cabinet. Counting from the bottom, locate and mark the mounting holes on both front cabinet uprights. Refer to Figure 5–11.

3. Locate the plastic bag containing the 10-32 X 1/2 screws.

4. Locate the plastic bag containing the four nut bars.

5. Locate the plastic bag containing two electrostatic discharge (ESD) brackets.

6. At the front of the cabinet, mount the right-hand slide assembly to the front right cabinet upright using two 10-32 screws and one nut bar as shown in Figure 5–12.

7. Use the same procedure to mount the left-hand slide assembly to the front left cabinet upright.

8. Go to the rear of the cabinet. Insert one 10-32 screw through the left-hand cabinet upright, the top hole of the right-hand slide bracket, and the top hole of the nut bar (to hold the slide in place).

9. Use two more 10-32 screws to mount the ESD bracket to the upright as shown in Figure 5–12.

10. Use the same procedure to mount the left-hand slide assembly and ESD bracket to the rear right-hand cabinet upright.
Figure 5-9  Left-Hand Slide
Figure 5–10  Right-Hand Slide

11. Once both slides are mounted, go to the rear of the cabinet and tighten the screws holding the slides to the slide brackets. These brackets were left loose for adjustment. Do this for both slides.
Figure 5–11 Cabinet Upright Holes (60-Inch Cabinet)
Figure 5–12 Mounting the Slide Assembly
5.9 EXTENDING CABINET STABILIZER FOOT

The cabinet stabilizer foot is part of an interlock mechanism that prevents the drive cabinet from tipping forward when a drive is extended on its slides or when a new drive is installed into the cabinet. Extend the stabilizer foot forward from the center bottom of the drive cabinet and lower it until makes firm contact with the floor. Refer to Figure 5–13.

WARNING
Always extend the cabinet stabilizer foot completely forward before placing a drive on the slides or sliding a drive out of the cabinet. Failure to do so could cause equipment damage or bodily injury.

Also, do not push stabilizer foot in while drive is extended. Damage to cabinet interlock mechanism could result.

5.10 CABINET INTERLOCK

The cabinet interlock maintains cabinet stability and ensures operator safety. If the stabilizer foot is retracted, all drives are locked and cannot be extended on the slides. When the stabilizer foot is extended, the cabinet interlock mechanism is released to allow only one drive at a time to be extended.

5.10.1 Positioning Interlock Rod Actuator

Before the drive is installed, position the interlock rod actuator contained within the front-left upright of the cabinet to prevent damage to the interlock mechanism during drive installation. Do this by manually rotating the interlock rod actuator 90 degrees clockwise until the cutout portion of the rod actuator faces frontwards, ready to engage the drive actuator (Figure 5–14) of the drive.

NOTE
The rod actuator does not rotate unless the stabilizer foot is extended.

5.11 MOUNTING THE ADD-ON DRIVE ON THE SLIDES

Use the following procedure to mount the RA82 add-on drive on the slides. Refer to Figure 5–15.

WARNING
The cabinet stabilizer foot must be fully extended and locked (Section 5.9).

The RA82 disk drive weighs at least 61.2 Kg (135 pounds). DIGITAL recommends that you use an approved field service lifting device rated at 200 pounds (DIGITAL Part Number FC-10074-AC) to place the drive onto the chassis slides.

The head disk assembly (HDA) may be removed from the drive to reduce the total weight by approximately 35 pounds. Refer to Section 5.6 for instructions on HDA removal.
Figure 5–13  Stabilizer Foot Extension
Figure 5–14  Interlock Rod Actuator

5.11.1 Mounting the Drive Using an Approved Lifting Device

Use the following procedure to install an RA82 drive using an approved lifting device. If no lifting device is available refer to Section 5.11.2 for the proper procedure.

1. Pull the right and left slides out of the cabinet until they lock in place. Lift lock arm A on both arms and pull both slides out of the cabinet until they are fully extended forward. Refer to Figure 5–15.

2. Lift the drive with the lifting device.

3. Lower the drive onto the extended slides so the drive front bezel is about one inch forward of the front end of the slide.

WARNING
Make sure the drive mounting rails and slides engage properly. If not, the drive could fall between the slides.
4. Push the drive toward the rear of the slide assembly until it engages the top slide stops. Refer to Figure 5–15.

5. Insert the 8-32 x 5/16 mounting screws through the openings on each slide to secure the drive to the slide assemblies. Only the front screw holes in the drive will be visible.

6. Release the slide lock arm B on both slides and push the drive back slowly until the next drive mounting hole lines up with the keyhole opening in the slides. Refer to Figure 5–15.

7. Insert 8-32 x 5/16 screws into the keyhole openings on each slide to complete the mounting procedure of the drive to the slides.

8. Release slide lock arm A on both arms to push the drive the rest of the way into the cabinet. Refer to Figure 5–15.

NOTE
If the drive does not slide into the cabinet freely, loosen the front screws on the slide brackets and make the necessary adjustments before retightening them. Ensure the slide brackets are mounted in the proper cabinet upright holes and that there is enough vertical and horizontal play to allow the drives to move freely.

5.11.2 Mounting the Drive Without an Approved Lifting Device

If you do not have an approved lifting device available use the following procedure to install an RA82 disk drive. The following procedure requires three people.

WARNING
The slides must be fully extended and locked, and the cabinet stabilizer foot must be fully extended and locked before this procedure is attempted

1. Make certain the work area is clear of obstructions, cables, etc.

2. Place one person on each side of the unit.

3. Place one person at the front of the unit.

4. The two persons at the sides of the unit grasp the front and rear of the unit and using the leg muscles lift the unit together.

5. The person at the front of the unit removes the skid or other packaging material from the immediate area.

6. The person at the front of the unit guides the lifters and assures that the slides are locked and that the unit is resting on the slides correctly.

7. While the two are holding the RA82 in position, the third person starts two mounting screws on each side of the unit (the one closest to the front and the one closest to the rear).

8. Secure the remaining mounting hardware as required and continue with normal installation procedures.
Figure 5–15  Mounting the Drive on Slides
5.12 MOUNTING THE I/O BULKHEAD ON THE SDI INTERFACE BRACKET

Locate the I/O bulkhead shipped with the add-on disk drive (attached to the end of the SDI cable). Based on drive position, each I/O bulkhead must be mounted in a designated location on the SDI interface bracket. Using the two captive screws, mount the I/O bulkhead to the SDI interface bracket at the rear base of the drive cabinet as shown in Figure 5–16.

![I/O Bulkhead Mounting Diagram](CX-685C)

**Figure 5–16 I/O Bulkhead Mounting**

5.13 INSTALLING CABLE STANDOFF AND U-NUT

Cable standoffs and U-nuts are used with cable clamps in the four-high cabinet to hold the cables away from the rear vertical uprights. The number of cable standoffs to install depends upon the number of drives in the cabinet. Refer to Table 5–3 for the proper four-high RA82 cabinet installation holes.

Use the following procedure to mount each cable standoff and U-nut. Refer to Figure 5–17.

1. Locate the plastic bags containing the cable standoffs.
2. Locate the plastic bag containing the U-nuts.
3. Slide each U-nut over the hole of the rear vertical upright designated in Table 5–3. The threaded portion of the U-nut should face the inside of the cabinet.
4. Screw the standoff into the U-nut.
5.14 INSTALLING SDI CABLES

The 12-foot SDI cable shipped with all add-on drives is the internal cabinet cable that connects the drive to the I/O bulkhead. The external SDI cable attaches the drive cabinet to the disk controller in another cabinet.

When installing the SDI cables, you must choose which of the SDI cable installation procedures in the following paragraphs fits your needs. The first one describes how to install the SDI cables for the first add-on (lower-middle cabinet position). The second one describes how to install the SDI cables for the second add-on (bottom cabinet position). The third procedure describes how to install the SDI cables for the third add-on (top cabinet position).
External SDI cables from the central processing unit (CPU) or controller cabinet are connected to the inside of the I/O bulkhead (opposite side of the SDI interface bracket from the internal SDI cables). Refer to Figure 5–16.

Refer to Table 5–3 for the proper four-high RA82 cabinet installation holes.

5.14.1 Installing First Add-On Drive SDI Cables

Use the following procedure to install the SDI cables for the first add-on drive. Refer to Figure 5–18 to tie-wrap and route cables. Figure 5–19 shows the wiring diagram for two drives.

1. Install the bottom end of the SDI cable (end with I/O bulkhead) onto the SDI interface bracket at the base of the cabinet. Using the two captive screws, mount the I/O bulkhead in the internal SDI cable position designated for Drive 1 (Figure 5–16). Make sure drive port cable A plugs into the A connector and the port cable B plugs into the B connector of the I/O bulkhead.

   **NOTE**
   Mount the I/O bulkheads on the left side of the SDI interface bracket by turning them 180 degrees from those on the right side. This should be apparent when the screw holes are aligned.

2. Clamp the SDI cables to the cable retainers on the end of the drive slides and the cable standoffs (Figure 5–18).

3. Starting at the I/O bulkhead, tie-wrap the SDI cables to the vertical upright. Leave enough slack in the SDI cables so the drive can slide out the front of the cabinet to its fully extended position. Use as many tie wraps as needed to dress the cables properly.

4. Extend the cabinet stabilizer foot and then pull the add-on drive out of the cabinet to see if you left enough slack in the SDI cables. There shouldn’t be any tension placed on the cables. Adjust the SDI cable loops now, if necessary, so the cables are not be pinched when the drive slides in and out.

This completes the SDI cable installation for the first add-on drive. Go to Section 5.15 to add the sequence cables.

5.14.2 Installing Second Add-On Drive SDI Cables

Use the following procedure to install the SDI cables for the second add-on drive. Refer to Figure 5–20. Refer to Figure 5–18 to tie-wrap and route the cables.

1. Install the bottom end of the SDI cable (end with I/O bulkhead) from the second add-on drive into the SDI interface bracket at the base of the cabinet. Using the two captive screws, mount the I/O bulkhead in the internal SDI cable position designated for Drive 2 (Figure 5–16). Make sure drive port cable A plugs into the A connector and the port cable B plugs into the B connector of the I/O bulkhead.

   **NOTE**
   Mount the I/O bulkheads on the left side of the SDI interface bracket by turning them 180 degrees from those on the right side. This should be apparent when the screw holes are aligned.

2. Clamp the SDI cables to the cable retainers on the end of the drive slides and the cable standoffs (Figure 5–18).
Figure 5-18  RA82 Cable Routing and Connections
NOTE 1: ALL PORT A CONNECTIONS GO TO SDI CONTROLLER A. ALL PORT B CONNECTIONS GO TO SDI CONTROLLER B.
NOTE 2: HEAVY LINE INDICATES DRIVE SEQUENCE CABLE.

Figure 5–19  Cable Wiring Diagram (First Add-On RA82)
NOTE 1: ALL PORT A CONNECTIONS GO TO SDI CONTROLLER A. ALL PORT B CONNECTIONS GO TO SDI CONTROLLER B.
NOTE 2: HEAVY LINE INDICATES DRIVE SEQUENCE CABLE.

Figure 5-21   Cable Wiring Diagram (Third Add-On RA82)
Figure 5–22  Cable Wiring Diagram - External Drive (Generic)

5.15.1 Installing First Add-On Drive Sequence Cables

Use the following procedure and Figure 5–19 to install the drive sequence cables on the first RA82 add-on drive (Drive 1). This procedure assumes the original drive (Drive 0) is also an RA82.

1. Install a sequence plug in the in connector.
2. Install a sequence cable between the OUT connector on the back of the original drive and the IN connector on the back of the first add-on drive.

3. Tie wrap the sequence cables to the SDI cables, leaving enough slack in the cables so the drive can slide out the front of the cabinet.

4. Extend the cabinet stabilizer foot and then pull the add-on drive out of the cabinet to check if you left enough slack in the sequence cables.

5. Use as many tie wraps as needed to dress the cables properly.

6. Be sure cables are not pinched when drive is moved in and out.

5.15.2 Installing Second Add-On Drive Sequence Cables

Use the following procedure and Figure 5–20 to install the sequence cables onto the second RA82 add-on drive (Drive 2). This procedure assumes the drives already mounted are RA82 drives.

1. Install a second sequence cable between the IN connector on the back of second add-on drive and connect it to the OUT connector on the first add-on drive.

2. Tie wrap the sequence cables to the SDI cables, leaving enough slack in the cables so the drive can slide out the front of the cabinet.

3. Extend the cabinet stabilizer foot, then pull the add-on drive out of the cabinet to check if you left enough slack in the sequence cables.

4. Use as many tie wraps as needed to dress the cables properly.

5. Be sure cables are not pinched when drive is moved in and out.

5.15.3 Installing Third Add-On Drive Sequence Cables

Use the following procedure and Figure 5–21 to install the sequence cables onto the third RA82 add-on drive (Drive 3). This procedure assumes the drives already mounted are RA82 drives.

1. Install a third sequence cable from the IN connector on the third add-on drive to the OUT connector on the second add-on drive.

2. Tie wrap the sequence cables to the SDI cables, leaving enough slack in the cables so the drive can slide out the front of the cabinet.

3. Extend the cabinet stabilizer foot and then pull the add-on drive out of the cabinet to check if you left enough slack in the sequence cables.

4. Use as many tie wraps as needed to dress the cables properly.

5. Be sure cables are not pinched when drive is moved in and out.

Refer to Table 5–3 for tie-wrap hole locations.

5.16 INSTALLING SEQUENCE TERMINATOR PLUG

Check to see if there is a drive sequence terminator plug at the IN connector on Drive 0 (second down from the top). One should be there already. If it is not, use the terminator plug (Part Number 70-19692-01) that comes in the add-on RA8X drive hardware kit. Refer to the insert on Figure 5–18.

The sequence terminator plug position would change if this cabinet were externally connected to other drives (Figure 5–22).
5.17 INSTALLING DISK DRIVE POWER CORD

The installation of the disk drive power cord varies depending on whether you are installing the first, second, or third add-on drive. In general, however, power cords are routed with the SDI cables. This is shown in the fully-loaded cabinet configuration of Figure 5–18.

Route and plug the disk drive power cords from each drive into the receptacles designated in Figure 5–23. The disk drive power requirements must be equally distributed between the three phases of the power controller (Section 5.18). Secure the power cords over the base of the cabinet with cable mounts and tie wraps as shown.

5.18 POWER CONTROLLERS

The 881 power controller was developed for the H9646-AH/AJ series cabinets.

A general-purpose, three-phase power controller controls and distributes ac power to various ac devices packaged in an operating system. In addition, both versions (A and B) are fully filtered, contain nine outlets, and are packaged in a 3.4-inch enclosure. For detailed information and instructions on how to operate the 881 power controller, refer to the 881 Power Controller User Guide included with this cabinet. See Section 2.2 for information on power control switches.

CAUTION
The nine outlets on the 881 power controller are divided into three outlets per phase. To prevent load imbalance, equally distribute the power to the drives between all three phases of the power controller. Refer to the appropriate cable wiring diagram in this chapter for proper power controller connections.

5.19 REPLACING THE HDA

If you removed the HDA before installing the add-on RA82 drive on the slides, use the following procedure to replace the HDA. Refer to the appropriate disk drive user guide if the drive is an RA80 or RA81.

CAUTION
For drive protection, use a grounding (electrostatic discharge) wrist strap during the following procedures (Figure 5–3). Also, read Section 1.7 for information on ESD protection.

1. Check that the cable spring assembly is in the RELEASED position (towards the rear). Refer to Figure 5–7.

2. Position the motor/brake assembly towards front of drive (swing slightly out on pivot rod) to take tension off drive belt.

3. Center the drive belt on the belt ramp bracket on the lower chassis as illustrated in Figure 5–24.

   CAUTION
   Damage to the HDA or drive belt may result if the drive belt is not aligned correctly.

4. Lift the HDA by grasping it from diagonally opposite corners (Figure 5–8). The HDA weighs approximately 35 pounds.

5. Lower the HDA over the four mounting bolts
Figure 5-23  Routing Power Cords on Cabinet Floor (Four-High)
Figure 5–24  Belt Alignment

6. Replace the four nuts and washers holding the HDA to its mounting bolts, and firmly tighten the four nuts to the mounting bolts with a 7/16-inch nut driver. Refer to Figure 5–6.

7. Connect P502 from the read/write module (Figure 5–6).

8. Connect P602 and P603 from the HDA preamplifier module (Figure 5–6).

9. Lock the positioner in the UNLOCK position (Figure 5–8). The lever must be lifted slightly to clear the surface of the read/write module.

10. Place the cable spring assembly in the ENGAGED position (Figure 5–7).

11. Position the read/write cable between the ribs on HDA housing to assure that the cable does not get pinched when the cover is closed. See Figure 5–6.
6 INSTALLING RA82 ADD-ON DRIVES IN AN SA482

6.1 INTRODUCTION
This chapter describes how to install RA82 disk drives into an SA482 cabinet.

6.2 UNPACKING THE ADD-ON DRIVE FROM THE BOX
Open the add-on drive box and check the contents listed in the following sections.

6.2.1 Add-On Hardware Mounting Kit Parts Checklist
Inside the plastic bag(s) of the add-on hardware kit, you should find the following parts. Use this check list to make sure they are all present.

Table 6–1 RA82 Add-On Drive Checklist

<table>
<thead>
<tr>
<th>Quan</th>
<th>Part Description</th>
<th>Part Number</th>
<th>Rev</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RA82 disk drive</td>
<td>70-21577-01 (60 Hz) or 70-21577-02 (50 Hz)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>RA82 hardware mounting kit(checklist below)</td>
<td>70-20194-02¹</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Chassis slide set (containing left and right slides)</td>
<td>12-13686-00</td>
<td>K</td>
</tr>
<tr>
<td>1</td>
<td>Power cord, disk drive, 9 feet</td>
<td>17-00083-23 (125 volts) or 17-00083-24 (250 volts)</td>
<td>L</td>
</tr>
<tr>
<td>1</td>
<td>Power cord, disk drive, 9 feet, 15A</td>
<td>17-00442-19</td>
<td>A</td>
</tr>
<tr>
<td>1</td>
<td>Cable, SDI, 12 feet (internal)</td>
<td>BC26V-12</td>
<td></td>
</tr>
</tbody>
</table>

¹The 70-20194-02 hardware kit is used to mount RA82 disk drives into three- and four-high cabinets, including SA cabinets.
6.2.2 Add-On Hardware Mounting Kit Parts Checklist

Inside the plastic bag(s) of the add-on hardware kit, you should find the following parts. Use Table 6–2 to make sure they are all present.

<table>
<thead>
<tr>
<th>Quan</th>
<th>Description</th>
<th>Part Number</th>
<th>Min Rev</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Retainer, cable spring</td>
<td>74-25326-01</td>
<td>A</td>
</tr>
<tr>
<td>4</td>
<td>Brackets, chassis slide</td>
<td>74-19261-00</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Cable, drive sequence, 8-foot</td>
<td>70-19690-08</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Brackets, ESD (not used on SA cabinets)</td>
<td>74-28330-01</td>
<td>A</td>
</tr>
<tr>
<td>1</td>
<td>Plug</td>
<td>70-19692-01</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Bar, nut</td>
<td>74-25168-01</td>
<td>CR</td>
</tr>
<tr>
<td>16</td>
<td>Screws, Sems Pan Phillip, 8/32 x 5/16-inch</td>
<td>90-10174-01</td>
<td>C</td>
</tr>
<tr>
<td>13</td>
<td>Screws, Sems Truss Phillip, 10/32 x 1/2-inch</td>
<td>90-09700-00</td>
<td>A</td>
</tr>
<tr>
<td>3</td>
<td>Clamp, cable, screw mounted, 11/16-inch</td>
<td>90-07088-00</td>
<td>CR</td>
</tr>
<tr>
<td>25</td>
<td>Ties, cable, 1 3/4-inch</td>
<td>90-07032-00</td>
<td>D</td>
</tr>
<tr>
<td>5</td>
<td>Washers, flat SST</td>
<td>90-06664-00</td>
<td>CR</td>
</tr>
<tr>
<td>5</td>
<td>Retainer, U-nut, 10-32</td>
<td>90-07786-00</td>
<td>F</td>
</tr>
<tr>
<td>3</td>
<td>Standoff, male/female, hex 10-32</td>
<td>90-00001-22</td>
<td>A</td>
</tr>
<tr>
<td>1</td>
<td>Spacer, threaded, hex 10-32</td>
<td>90-07662-00</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Washer, shoulder nylon (not used on SA)</td>
<td>12-19700-02</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Standoff, 6-32 (SA cabinets only)</td>
<td>90-00001-06</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Cover, control panel (SA cabinets only)</td>
<td>74-34388-01</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Bracket, ESD (SA cabinets only)</td>
<td>74-36472-01</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Screw, 10-32 .625 (SA cabinets only)</td>
<td>12-21368-02</td>
<td></td>
</tr>
</tbody>
</table>

6.3 PREPARING THE SA482

In order to add an RA82 disk drive to the SA482 cabinet, the SA482 must be spun down and power removed.

1. Release the A and the B port buttons on the operator control panel to the OUT position on each drive in the SA482.
2. Spin down the SA482 by releasing the **RUN/STOP** button on the operator control panel on the front of each disk drive to the **OUT** position.

### 6.3.1 Removing the Rear Door

Press down on each of the two latch release buttons. Then lift and remove the door from the bottom two support brackets. Refer to Figure 6–1.

![Diagram of removing the rear door](CX-689A)

**Figure 6–1  Removing the Rear Door**

**CAUTION**
Before proceeding, turn OFF the ac circuit breaker for each drive and for the cabinet.
6.3.2 Removing the Front Door

Obtain access to the drive elements in the SA482 by loosening the two hex latch releases (Figure 6–2) located at the top of the SA482 front door and lifting the panel up and out. Replacement of the door panel is the reverse procedure of removal.

Figure 6–2 Disk Drive Access in SA482
6.3.3 Front Door Filler Plate Removal

Carefully remove the appropriate front door filler plate from inside the front door. This filler plate is held in place by two screws accessible from the inside of the front door. Refer to Figure 6–3.

![Diagram of front door filler plate removal](cx-2091a)

Figure 6–3  Filler Plate Removal

6.3.4 Extending the Cabinet Stabilizer Foot

The cabinet stabilizer foot prevents the drive cabinet from tipping forward when a drive is extended on its slides or when a new drive is installed in the cabinet. Extend the foot forward from the center bottom of the drive cabinet and lower it until it makes firm contact with the floor. Refer to Figure 6–4.

**WARNING**

Always extend the cabinet stabilizer foot completely forward before placing a drive on the slides or sliding a drive out of the cabinet.
Figure 6–4  Stabilizer Foot Extension

CAUTION
Do not push the stabilizer foot in while the drive is extended.

6.4 PREPARING THE ADD-ON DRIVE FOR INSTALLATION

Each RA82 disk drive in the SA482 cabinet must be mounted on a slide assembly. Use the procedures in the following sections to prepare the add-on drive for installation.

NOTE
Since the drive weighs at least 61.2 Kg (135 pounds), DIGITAL recommends that an approved field service lifting device rated at 200 pounds (DIGITAL Part Number FC-10074-AC) be used to place the drive on the chassis slides.

If an approved lifting device is not available, at least three persons are required to lift and install the disk drive. Refer to Section 6.7.2 for the proper procedure.

The head disk assembly (HDA) may be removed from the drive to reduce the total weight by approximately 35 pounds. Refer to Section 6.16 for instructions on HDA removal.
6.4.1 Removing Internal Shipping Brackets and Packing Material

Packing material and shipping brackets are inside the chassis of each disk drive. Use the following procedure to remove the brackets and material and prepare the drive for installation.

CAUTION
Use a grounding (electrostatic discharge) wrist strap during the following procedures for drive protection (Figure 6–5). Also, read Section 1.7 for information on ESD protection.

Figure 6–5 Connecting ESD Wrist Strap to Ground

1. Unlock the upper chassis assembly by turning the two cam latches under the front bezel 180 degrees counterclockwise with a 5/16-inch allen hex wrench. Refer to Figure 6–6.

2. Raise the upper chassis assembly until the damper (gas spring) lock slides in place and the cover is supported by the damper (Figure 6–7).

CAUTION
To prevent HDA and head damage, never open or close the upper chassis assembly while the drive is operating.
Figure 6–6  Upper Chassis Assembly
Figure 6–7  Damper (Gas Spring) Assembly

3. Locate the three red shipping brackets that fasten the HDA to its mountings. Refer to Figure 6–8.

4. Remove the three red shipping brackets by unscrewing the 7/16-inch hex retaining nuts and removing the number 10 (5/32 A/F) allen cap screws and cap screw washers from the sides of the brackets.
Figure 6-8  HDA Shipping Brackets
5. Slide the shipping brackets out from under the HDA retaining nuts, and remove the cap screw and cap screw washers. Refer to Figure 6–8. The HDA retaining nuts are used to hold down the HDA after the shipping brackets are removed.

**NOTE**

Save all shipping brackets and hardware for future use when moving equipment.

6. Remove the foam shipping block from between the spindle motor and the right rear HDA bracket. Refer to Figure 6–8.

7. Firmly tighten all four HDA retaining nuts with a 7/16-inch nut driver. Refer to Figure 6–9.

---

**Figure 6–9  HDA Details**

8. Ensure the cable spring assembly is in the ENGAGED position as shown in Figure 6–10.
Figure 6–10  Cable Spring Assembly

NOTE
An interlock switch prevents the spindle motor from operating while the cable spring assembly tension is released. The cable spring assembly must be in the ENGAGED position for spinup.

9. Remove positioner lock seal and place the positioner lock lever on the HDA in the UNLOCK position (Figure 6–8).
10. Unlock the logic access cover by manually turning the two captive fastener assembly screws several turns counterclockwise. Release and tighten these screws by hand only. Refer to Figure 6–11.

11. Fold out the logic access cover.

12. Check all modules, cables, and connections. Make sure all cable connectors are firmly seated in the mating connectors.

**NOTE**

Visually inspect all modules and components for obvious damage. DO NOT operate equipment if components are damaged. Report all damage to the DIGITAL field service or sales office and to the delivery agent.

13. Return the logic access cover to its original closed position. Lock the two captive fastener assembly screws by manually turning them clockwise. Make sure the logic access cover is securely locked in place. Refer to Figure 6–11.

14. Position the read/write cable between ribs on the HDA to assure that the cable does not get pinched when the cover is closed. Refer to Figure 6–9.

**CAUTION**

Do not pinch cables when lowering the upper chassis assembly. Check cable locations and reroute cables, if necessary, before lowering.
Figure 6–11 Opening the Logic Access Cover

15. Remove and discard the eight screws that hold the bezel in place. Refer to Figure 6–12 for screw location.
Figure 6–12  RA82 Front Bezel Removal

16. Remove and discard the bezel and filter foam.

17. Gently lift up on the upper chassis assembly to take the weight off the gas spring. Unlock the gas spring by pulling the locking knob out while still supporting the weight of the upper chassis assembly. Refer to Figure 6–7.

18. Slowly lower the upper chassis assembly until resistance from the gas spring is felt. When resistance is sufficient to ensure the gas spring will allow the logic to close slowly, release your hold on the upper chassis assembly. Lock in place by turning the two cam latches under the front bezel 180 degrees clockwise with a 5/16-inch allen hex wrench. Refer to Figure 6–6.

CAUTION

DO NOT permit the upper chassis to free fall and DO NOT force the upper chassis assembly against the gas spring pressure.
If you do not need to remove the HDA, follow the procedures beginning in Section 6.5 to install the slides and mount the disk drive into the cabinet.

6.5 PREPARING THE SLIDES FOR CABINET MOUNTING

Use the following procedure to prepare the cabinet slide assemblies for installation. Assemble the left-hand slide assembly first.

1. Locate the left-hand slide that has part number 1213686-00-REV-X-L engraved on it. The revision level of the slide was given as X because it changes occasionally. The letter L indicates this is the left-hand slide.

2. Locate the plastic bag containing four slide brackets.

3. Locate the plastic bag containing the 8-32 X 5/16 screws.

4. Lay the left-hand slide on its back and push the lower half of the slide to the left to gain access to the rear mounting holes. (Figure 6–13).

5. Use two 8-32 screws to mount the rear slide bracket to the slide as shown in Figure 6–13. Don’t tighten the screws all the way since some leeway is needed later when the slides are mounted into the cabinet.

6. Use two more 8-32 screws to mount the front slide bracket to the left-hand slide. The screws must be inserted into the mounting holes through the oval opening on the slide. Tighten the two screws.

7. Press the two front leafs of the L-shaped cable retainer together and force the retainer into the rear end of the left-hand slide assembly as shown in Figure 6–13.

8. Locate the drive right-hand slide that has part number 1213686-00-REV-X-R engraved on it. The revision level of the slide was given as X because it changes occasionally. The letter R indicates this is the right-hand slide.

9. Lay the right-hand slide on its back and push the lower half of the slide to the right to gain access to the rear mounting holes (Figure 6–14).

10. Use two 8-32 screws to mount the rear slide bracket to the slide. Don’t tighten the screws all the way since some leeway is needed when the slides are later mounted into the cabinet.

11. Use two more 8-32 screws to mount the front slide bracket to the right-hand slide. Insert the screws into the slide mounting holes by aligning the oval opening over them. Tighten the two screws.

Both slides are now prepared for installation into the drive cabinet.
Figure 6-13 Preparing Left-Hand Slide
Figure 6–14 Preparing Right-Hand Slide

6.6 INSTALLING CABINET SLIDES

Use the following procedures to install the slides and associated hardware in the cabinet. Refer to Table 6–3 for the proper SA482 cabinet installation holes.
### Table 6–3  SA482 Installation Holes

<table>
<thead>
<tr>
<th>Drive Position</th>
<th>FRONT Slide Holes</th>
<th>REAR Slide Holes</th>
<th>RIGHT REAR* Clamp/Standoff</th>
<th>LEFT REAR* Clamp/Standoff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive 3</td>
<td>66, 70</td>
<td>70, 69, 67</td>
<td>Not used</td>
<td>71</td>
</tr>
<tr>
<td>Drive 0</td>
<td>48, 52</td>
<td>52, 51, 49</td>
<td>53</td>
<td>48</td>
</tr>
<tr>
<td>Drive 1</td>
<td>27, 31</td>
<td>31, 30, 28</td>
<td>43</td>
<td>27</td>
</tr>
<tr>
<td>Drive 2</td>
<td>9, 13</td>
<td>13, 12, 10</td>
<td>22</td>
<td>9</td>
</tr>
</tbody>
</table>

* RIGHT REAR refers to the right rear vertical upright as viewed from the front of the cabinet. LEFT REAR refers to the left rear vertical upright as viewed from the front of the cabinet.

1. Go to the rear of the drive cabinet. Counting from the bottom, locate and mark the mounting holes in both rear cabinet uprights. Refer to Figure 6–15.

2. Go to the front of the drive cabinet. Counting from the bottom, locate and mark the mounting holes on both front cabinet uprights.
3. Locate the plastic bag containing the 10-32 X 1/2 screws.

4. Locate the plastic bag containing the four nut bars.

5. Locate the plastic bag containing two electrostatic discharge (ESD) brackets.

6. At the front of the cabinet, mount the right-hand slide assembly to the front right cabinet upright using two 10-32 screws and one nut bar as shown in Figure 6–16. Refer to Table 6–3.

7. Secure the back of the slide assembly to the rear frame with 10-32 SEMs screws (Part Number 90-09700-00). Refer to Table 6–3 for appropriate hole locations.
8. Once both slides are mounted, go to the rear of the cabinet and tighten the screws holding the slides to the slide brackets. Do this for both slides (these brackets were left loose for adjustments).
Figure 6–16  Mounting the Slide Assembly
WARNING
Always extend the cabinet stabilizer foot completely forward before placing a drive on the slides or sliding a drive out of the cabinet.

Also, do not push the stabilizer foot in while the drive is extended or damage to the cabinet interlock mechanism could result.

6.7 MOUNTING THE ADD-ON DRIVE ON THE SLIDES
Use the following procedures to mount the add-on drive on the slides. Refer to Figure 6–17.

CAUTION
The cabinet stabilizer foot must be fully extended and locked (Figure 6–4).

6.7.1 Installing an RA82 Using a Lifting Device
Use the following procedure if you are using an approved lifting device (DIGITAL Part Number FC-10074-AC) to install the RA82 disk drive.

1. Be certain that you have removed the front bezel of the disk drive.

2. Pull the right and left slides out of the cabinet until they lock in place. Then lift up the lock arm A on both arms and pull both slides out of the cabinet until they are fully extended forward. Refer to Figure 6–17.

3. Lift the drive with the lifting device.

NOTE
Since the drive weighs at least 61.2 Kg (135 pounds), DIGITAL recommends that an approved field service lifting device rated at 200 pounds (DIGITAL Part Number FC-10074-AC) be used to place the drive onto the chassis slides.

If an approved lifting device is not available, at least three persons are required to lift and install the disk drive. Refer to Section 6.7.2 for the proper procedure.

The head disk assembly (HDA) may be removed from the drive to reduce the total weight by approximately 35 pounds. Refer to Section 6.16 for instructions on HDA removal.

4. Lower the drive onto the extended slides so the drive front bezel is about one inch forward of the front end of the slide.

CAUTION
Make sure the drive mounting rails and slides engage properly. If not, the drive could fall between the slides.

5. Push the drive towards the rear of the slide assembly until it engages the top slide stops. Refer to Figure 6–17.

6. Insert the 8-32 x 5/16 mounting screws through the openings on each slide to secure the drive to the slide assemblies. Only the front screw holes in the drive will be visible. The slides must be unlocked and moved to expose the rear screw holes. Refer to Figure 6–17.
Figure 6–17  Mounting the Drive on Slides
7. Release the slide lock arm B on both slides and push the drive back slowly until the next drive mounting hole lines up with the keyhole opening in the slides. Refer to Figure 6–17.

8. Insert 8-32 X 5/16 screws into the keyhole openings on each slide to complete the mounting procedure of the drive to the slides.

NOTE
If you have removed the HDA to install the drive into the cabinet, replace the HDA into the drive at this time (Section 6.17).

6.7.2 Installing an RA82 Without a Lifting Device

Use the following procedure to install an RA82 disk drive without an approved lifting device. The following procedure requires three people to complete.

WARNING
Fully extend and lock the slides and the cabinet stabilizer foot before attempting this procedure.

1. Make certain the work area is clear of obstructions, cables, etc.

2. Place one person on each side of the unit.

3. Place one person at the front of the unit.

4. The two persons at the sides of the unit grasp the front and rear of the unit and using the leg muscles lift the unit together.

5. The person at the front of the unit removes the skid or other packaging material from the immediate area.

6. The person at the front of the unit guides the lifters and assures that the slides are locked and that the unit is resting on the slides correctly.

7. While the two are holding the RA82 in position, the third person starts two mounting screws on each side of the unit (the one closest to the front and the one closest to the rear).

8. Secure the remaining mounting hardware as required and continue with normal installation procedures.

6.8 SECURE THE DRIVE TO THE TWO ESD BRACKETS

Use the following procedure to attach the drive to the ESD brackets included in the add-on hardware kit.

1. Remove the bottom left and the top right OCP mounting screws. Refer to Figure 6–18 for locations.

2. Install the 6-32 x 1.375 standoffs (Part Number 90-00001-06) in place of the two screws removed in step 1.

NOTE
Install the standoffs finger tight. Do not use a wrench.

3. Install the control panel cover (Part Number 74-34388-01), using the two screws removed in step 1. The textured surface of the cover should be to the front.
4. Attach the ESD brackets (Part Number 74-34389-01) behind the vertical flanges on the logic housing using 8-32 screws (Part Number 90-10174-01) (two brackets, one to each side, two screws per bracket). *Do not tighten these screws.* See Figure 6–18.

![Diagram of SA482 ESD Brackets]

**Figure 6–18  SA482 ESD Brackets**

**NOTE**
The ESD brackets also serve as drive retainer brackets.

5. Release the slide latches and push the drive almost all the way back into the cabinet. The lower holes on each ESD bracket will line up with a hole on the cabinet upright. Install a U-nut (Part Number 90-07786-00) in each of these holes. The threaded side of the U-nut goes to the inside of the upright. Refer to Table 6–3.
6. Release slide lock arm on both arms to push the drive the rest of the way into the cabinet. Refer to Figure 6–17. Attach the ESD brackets to the uprights using the 10-32 Truss screws (Part Number 9009700-00), one to each side. Tighten the ESD bracket screws left loose earlier. Refer to Figure 6–18.

**NOTE**
If the drive does not slide into the cabinet freely, loosen the front screws on the slide brackets and make the necessary adjustments before tightening them again. Also ensure the slide brackets are mounted in the proper cabinet upright holes and that there is enough vertical and horizontal play to allow the drives to move freely.

7. Retract the stabilizing foot.

### 6.9 MOUNTING THE I/O BULKHEAD ON THE SDI INTERFACE BRACKET

Locate the I/O bulkhead that came with the add-on disk drive (it should be attached to the end of the SDI cable). Based on drive position, each I/O bulkhead must be mounted in a designated location on the SDI interface bracket. Using the two captive screws, mount the I/O bulkhead to the SDI interface bracket at the rear base of the drive cabinet as shown in Figure 6–19.

![Diagram of I/O Bulkhead Mounting](CX-685C)
6.10 INSTALLING CABLE STANDOFF AND U-NUT

Cable standoffs and U-nuts are utilized with cable clamps in the four-high cabinet to hold the cables away from the rear vertical uprights. The number of cable standoffs to install depends upon the number of drives in the cabinet.

Use the following procedure to mount each cable standoff and U-nut. Refer to Figure 6–20.

1. Locate the plastic bags containing the cable standoffs.
2. Locate the plastic bag containing the U-nuts.
3. Slide each U-nut over the hole of the rear vertical upright designated in Table 6–3. The threaded portion of the U-nut should face the inside of the cabinet.
4. Screw the standoff into the U-nut.

The SDI cables are installed next.
Figure 6–20  Mounting U-Nut and Standoffs

6.11  INSTALLING SDI CABLES

The 12-foot SDI cable shipped with all add-on drives is the internal cabinet cable that connects the drive to the I/O bulkhead. The external SDI cable attaches the drive cabinet to the disk controller in another cabinet.

When installing the SDI cables, you must choose which of the SDI cable installation procedures in the following paragraphs fits your needs. The first one describes how to install the SDI cables for the first add-on (bottom cabinet position). The second procedure describes how to install the SDI cables for the second add-on (top cabinet position).
External SDI cables from the central processing unit (CPU) or controller cabinet are connected to the inside of the I/O bulkhead (opposite side of the SDI interface bracket from the internal SDI cables). Refer to Figure 6–19.

6.11.1 First Add-On Drive SDI Cable

Use the following procedure to install the SDI cables for the first add-on drive. Refer to Figure 6–21. Refer to Figure 6–22 to tie-wrap and route the cables.
NOTE 1: ALL PORT A CONNECTIONS GO TO SDI CONTROLLER A. ALL PORT B CONNECTIONS GO TO SDI CONTROLLER B.

NOTE 2: HEAVY LINE INDICATES DRIVE SEQUENCE CABLE.

CX-1015B

Figure 6-21  Cable Wiring Diagram (First Add-On RA82)
1. Install the bottom end of the SDI cable (end with I/O bulkhead) from the first add-on drive into the SDI interface bracket at the base of the cabinet. Using the two captive screws, mount the I/O bulkhead in the internal SDI cable position designated for Drive 2 (Figure 6–19). Make sure drive port cable A plugs into the A connector and the port cable B plugs into the B connector of the I/O bulkhead.

**NOTE**
Mount the I/O bulkheads on the left side of the SDI interface bracket by turning them 180 degrees from those on the right side. This should be apparent when the screw holes are aligned.

2. Clamp the SDI cables to the cable retainers on the end of the drive slides and the cable standoffs (Figure 6–22).

3. Starting at the I/O bulkhead, tie-wrap the SDI cables to the vertical upright. Leave enough slack in the SDI cables so the drive can slide out the front of the cabinet to its fully extended position. Use as many tie wraps as needed to dress the cables properly.

4. Extend the cabinet stabilizer foot and then pull the drive out of the cabinet to check if there is enough slack in the SDI cables. If not, adjust the cable loop size.

This completes the SDI cable installation for the first add-on drive. The sequence cables are added next.
Figure 6–22  RA82 Cable Routing and Connections
6.11.2 Second Add-On Drive SDI Cable

Use the following procedure to install the SDI cables for the second add-on drive. Refer to Figure 6–23. Refer to Figure 6–22 to tie-wrap and route the cables.

1. Install the bottom end of the SDI cable (end with I/O bulkhead) from the second add-on drive into the SDI interface bracket at the base of the cabinet. Using the two captive screws, mount the I/O bulkhead in the internal SDI cable position designated for Drive 3 (Figure 6–19). Make sure the drive port cable A plugs into the A connector and the B port cable plugs into the B connector of the I/O bulkhead.

**NOTE**
Mount the I/O bulkheads on the left side of the SDI interface bracket by turning them 180 degrees from those on the right side. This should be apparent when the screw holes are aligned.

2. Clamp the SDI cables to the cable retainers on the end of the drive slides and the cable standoffs (Figure 6–22).

3. Starting at the I/O bulkhead, tie-wrap the SDI cables to the vertical upright. Leave enough slack in the SDI cables so the drive can slide out the front of the cabinet to its fully extended position. Use as many tie wraps as needed to dress the cables properly.

4. Extend the cabinet stabilizer foot and then pull the drive out of the cabinet to check if there is enough slack in the SDI cables. If not, adjust the cable loop size.

Figure 6–24 shows the wiring diagram for external drives.

This completes the SDI cable installation for the second add-on drive. The sequence cables are added next (Section 6.12).
NOTE 1: ALL PORT A CONNECTIONS GO TO SDI CONTROLLER A. ALL PORT B CONNECTIONS GO TO SDI CONTROLLER B.
NOTE 2: HEAVY LINE INDICATES DRIVE SEQUENCE CABLE.

Figure 6-23  Cable Wiring Diagram (Second Add-On RA82)
6.12 INSTALLING SEQUENCE CABLE

All RA8X disk drives need drive sequence cables. Sequence cables permit only one drive to start at a time. The following drive sequence cable procedures assume only RA82s are used in the cabinet. Refer to Figure 6–22 to tie-wrap and route the cables.
CAUTION
Sequence cables MUST be installed. If not, disk/data corruption or damage may result during or after a system power failure.

6.12.1 First Add-On Drive Sequence Cable
Use the following procedure and Figure 6–21 to install the sequence cables onto the first RA82 add-on drive (Drive 2). This procedure assumes the drives already mounted are RA82 drives.

1. Install a sequence cable between the IN connector on the back of first add-on drive (Drive 2) and connect it to the OUT connector on Drive 1.

2. Tie wrap the sequence cables to the SDI cables, leaving enough slack in the cables so the drive can slide out the front of the cabinet.

3. Extend the cabinet stabilizer foot, then pull the add-on drive out of the cabinet to check if you left enough slack in the sequence cables.

4. Use as many tie wraps as needed to dress the cables properly.

5. Be sure cables are not pinched when drive is moved in and out.

6.12.2 Second Add-On Drive Sequence Cable
Use the following procedure and Figure 6–23 to install the sequence cables onto the second RA82 add-on drive (Drive 3). This procedure assumes the drives already mounted are RA82 drives.

1. Install a sequence cable from the IN connector on the second add-on drive (Drive 3) to the OUT connector on the first add-on drive (Drive 2).

2. Tie wrap the sequence cables to the SDI cables, leaving enough slack in the cables so the drive can slide out the front of the cabinet.

3. Extend the cabinet stabilizer foot and then pull the add-on drive out of the cabinet to check if you left enough slack in the sequence cables.

4. Use as many tie wraps as needed to dress the cables properly.

5. Be sure cables are not pinched when drive is moved in and out.

6.13 INSTALLING SEQUENCE TERMINATOR PLUG
Check to see if there is a drive sequence terminator plug at the IN connector of Drive 0. If it is not, use the terminator plug (Part Number 70-19692-01) that comes in the add-on RA8X drive hardware kit. Refer to the insert on Figure 6–22.
6.14 INSTALLING DISK DRIVE POWER CORD

The installation of the disk drive power cord varies depending on whether you are installing the first or second add-on drive. In general, however, power cords are routed with the SDI cables. This is shown in the fully-loaded cabinet configuration of Figure 6–22.

Route and plug the disk drive power cords from each drive into the receptacles designated in Figure 6–25. The disk drive power requirements must be equally distributed between the three phases of the power controller (see Section 6.15). Secure the power cords over the base of the cabinet with cable mounts and tie wraps as shown.

Figure 6–25  Routing the Power Cords on Cabinet Floor (Four-High)
6.14.1 Closing the Cabinet

After installing the add-on drive(s) and connecting all cables and power cords, turn the circuit breaker for the cabinet to the ON position. Next turn the power ON to the drives.

Replace the rear bustle door (Figure 6–1).

Replace the front panel assembly (Figure 6–2).

Refer to Chapter 2 of this manual and spin up the drives.

6.15 POWER CONTROLLERS

The 881 power controller was developed for the H9646-AH/AJ series cabinets. It is a general-purpose, three-phase power controller that controls and distributes ac power to various ac devices packaged in an operating system. In addition, both versions (A and B) are fully filtered, contain nine outlets, and are packaged in a 3.4-inch enclosure. For detailed information and instructions on how to operate the 881 power controller, refer to the 881 Power Controller User Guide included with this cabinet.

CAUTION
The nine outlets on the 881 power controller are divided into three outlets per phase. To prevent load imbalance, distribute power to the drives equally between all three phases of the power controller. Refer to the appropriate cable wiring diagram in this chapter for proper power controller connections.

6.16 HDA REMOVAL

Use the following procedure to remove the head disk assembly (HDA) from the RA82 disk drive.

CAUTION
For drive protection, use a grounding (electrostatic discharge) wrist strap during the following procedures (Figure 6–5).

Procedures for access, removal, and replacement of the RA82 HDA are different from those of the RA80 or RA81. Refer to the appropriate user guide for the drive you are working with.

1. Unlock the upper chassis assembly by turning the two cam latches under the front bezel 180 degrees counterclockwise with a 3/16-inch allen hex wrench (Figure 6–6).
2. Raise the upper chassis assembly until the damper (gas spring) lock slides in place and supports the upper chassis assembly (Figure 6–7).
3. Unplug connector P502 from the read/write module (Figure 6–9).
4. Unplug connectors P602 and P603 from the HDA preamplifier module (Figure 6–9).
5. Place the cable spring assembly in the RELEASED position (Figure 6–10).
6. Remove the four HDA retaining nuts and washers (Figure 6–9).
7. Place the positioner lock in the LOCK position (Figure 6–26). The lever must be lifted slightly to clear the surface of the read/write module.

CAUTION
The HDA could be damaged if the positioner is not locked.
Figure 6–26  HDA Positioner Lock

8. Remove the HDA from the drive by lifting it from diagonally opposite corners (Figure 6–26). The HDA weighs approximately 35 pounds.

9. Place the HDA on a level surface in the vertical position only. Feet are provided on the front cover of the HDA for this purpose (Figure 6–26).

**CAUTION**

DO NOT place the HDA in a horizontal position (on the pulley) or the speed and temperature transducers mounted on the bottom of the HDA could be damaged.

If the HDA is to be moved or packed for shipment, use an HDA spindle pulley lock (DIGITAL Order Number 74-31667-01) to lock the spindle pulley in place. Any movement of the spindle could damage the heads.

10. Gently lift up on the upper chassis assembly to take the weight off of the gas spring. Unlock the gas spring by pulling the locking knob out while still supporting the weight of the upper chassis assembly. Refer to Figure 6–7.
11. Slowly lower the upper chassis assembly until resistance from the gas spring is felt. When resistance is sufficient to ensure the gas spring will allow the logic to close slowly, release your hold on the upper chassis assembly. Lock in place by turning the two cam latches under the front bezel 180 degrees clockwise with a 5/16-inch allen hex wrench. Refer to Figure 6–6.

CAUTION

DO NOT permit the upper chassis to free fall and DO NOT force the upper chassis assembly against the gas spring pressure.

Do not pinch cables when lowering the upper chassis assembly. Check cable locations and reroute cables, if necessary, before lowering.

You may now return to Section 6.5 to continue with the add-on procedure.

6.17 HDA REPLACEMENT (RA82)

If you removed the HDA before installing the add-on drive onto the slides, use the following procedure to replace the HDA. Refer to the appropriate disk drive user guide if the drive is an RA80 or RA81.

CAUTION

For drive protection, use a grounding (electrostatic discharge) wrist strap during the following procedures (Figure 6–5).

1. Check that the cable spring assembly is in the RELEASED position (towards the rear). Refer to Figure 6–10.

2. Position the motor/brake assembly towards front of drive (swing slightly out on pivot rod) to take tension off drive belt.

3. Center the drive belt on the belt ramp bracket on the lower chassis as illustrated in Figure 6–27.
CAUTION
Damage to the HDA or drive belt may result if the drive belt is not aligned correctly.

4. Lift the HDA by grasping it from diagonally opposite corners (Figure 6–26). The HDA weighs approximately 35 pounds.

5. Lower the HDA over the four mounting bolts (Figure 6–9).

6. Replace the four nuts and washers holding the HDA to its mounting bolts, and firmly tighten the four nuts to the mounting bolts with a 7/16 inch nut driver (Figure 6–9).

7. Connect P502 from the read/write module (Figure 6–9).

8. Connect P602 and P603 from the HDA preamplifier module (Figure 6–9).

9. Place the positioner lock in the UNLOCK position (Figure 6–26). The lever must be lifted slightly to clear the surface of the read/write module.

10. Place the cable spring assembly in the ENGAGED position (Figure 6–10).
11. Position read/write cable between ribs on HDA housing to assure that cable does not get pinched when cover is closed (Figure 6–9).

12. Gently lift up on the upper chassis assembly to take the weight off the gas spring. Unlock the gas spring by pulling the locking knob out while still supporting the weight of the upper chassis assembly (Figure 6–7).

13. Slowly lower the upper chassis assembly until resistance from the gas spring is felt. When resistance is sufficient to ensure the gas spring will allow the logic to close slowly, release your hold on the upper chassis assembly. Lock in place by turning the two cam latches under the front bezel 180 degrees clockwise with a 5/16-inch allen hex wrench. Refer to Figure 6–6.

CAUTION
*DO NOT* permit the upper chassis to *free fall* and *DO NOT* force the upper chassis assembly against the gas spring pressure.

6.18 CHECKING OUT THE DRIVE

After installing the add-on drive, check out the drive using the procedure described in Chapter 3.
Table A–1  RA82 LED Error Codes

<table>
<thead>
<tr>
<th>LED Error Code</th>
<th>Error Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Spin-up error, spindle motor transducer timeout</td>
</tr>
<tr>
<td>02</td>
<td>Spin-up error, 0-1000 r/min too slow</td>
</tr>
<tr>
<td>03</td>
<td>Spin-up error, spindle not accelerating</td>
</tr>
<tr>
<td>04</td>
<td>Spin-up error, too long to get up to speed</td>
</tr>
<tr>
<td>05</td>
<td>Spin up is inhibited, GRANT not present or SIP present</td>
</tr>
<tr>
<td>06</td>
<td>Microcode fault</td>
</tr>
<tr>
<td>07</td>
<td>Level-2 SDI command frame sequence error</td>
</tr>
<tr>
<td>08</td>
<td>Level-2 SDI command checksum error</td>
</tr>
<tr>
<td>09</td>
<td>SDI-command framing error</td>
</tr>
<tr>
<td>0A</td>
<td>SDI-command opcode parity error</td>
</tr>
<tr>
<td>0B</td>
<td>Invalid level-2 SDI command opcode</td>
</tr>
<tr>
<td>0C</td>
<td>Invalid level-2 SDI command length</td>
</tr>
<tr>
<td>0D</td>
<td>Attempt command while drive status error byte is nonzero</td>
</tr>
<tr>
<td>0E</td>
<td>Invalid group select error</td>
</tr>
<tr>
<td>0F</td>
<td>SDI write enable command while drive is hardware write protected</td>
</tr>
<tr>
<td>10</td>
<td>Slave sent invalid error code</td>
</tr>
<tr>
<td>11</td>
<td>Transfer command while no R/W ready</td>
</tr>
<tr>
<td>12</td>
<td>Transfer command while &quot;drive error&quot;</td>
</tr>
<tr>
<td>13</td>
<td>Failed to achieve fine track after seek</td>
</tr>
</tbody>
</table>
Table A–1 (Cont.) RA82 LED Error Codes

<table>
<thead>
<tr>
<th>LED Error Code</th>
<th>Error Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>Format attempted while format disabled</td>
</tr>
<tr>
<td>15</td>
<td>Illegal attempt to change 512/576 byte mode</td>
</tr>
<tr>
<td>17</td>
<td>Unable to find first track after guard band</td>
</tr>
<tr>
<td>18</td>
<td>AGC calibration timeout error</td>
</tr>
<tr>
<td>19</td>
<td>Seek or recalibration error during adaptive bias compensation</td>
</tr>
<tr>
<td>1A</td>
<td>Seek command contained an invalid cylinder address</td>
</tr>
<tr>
<td>1B</td>
<td>AGC calibration out of range</td>
</tr>
<tr>
<td>1C</td>
<td>Unit select number changed while on-line</td>
</tr>
<tr>
<td>1D</td>
<td>Controller timeout</td>
</tr>
<tr>
<td>1F</td>
<td>R/W sector overrun error</td>
</tr>
<tr>
<td>23</td>
<td>Spindle motor interlock error</td>
</tr>
<tr>
<td>24</td>
<td>Detent on wrong track after seek</td>
</tr>
<tr>
<td>25</td>
<td>Servo fault</td>
</tr>
<tr>
<td>26</td>
<td>Spindle speed less than 3420 r/min (3600 less 5 percent)</td>
</tr>
<tr>
<td>27</td>
<td>HDA temperature is too high</td>
</tr>
<tr>
<td>28</td>
<td>Servo temperature is too high</td>
</tr>
<tr>
<td>29</td>
<td>Invalid error recovery level specified</td>
</tr>
<tr>
<td>2A</td>
<td>Invalid subunit number specified</td>
</tr>
<tr>
<td>2B</td>
<td>Invalid test number specified in diagnose command</td>
</tr>
<tr>
<td>2C</td>
<td>Seek or recalibrate command received while spindle not ready</td>
</tr>
<tr>
<td>2E</td>
<td>Controller flags prohibit manual spin up</td>
</tr>
<tr>
<td>2F</td>
<td>Run command received while RUN/STOP switch in stop position</td>
</tr>
<tr>
<td>30</td>
<td>Write current and no write gate</td>
</tr>
<tr>
<td>31</td>
<td>Read gate and write gate</td>
</tr>
<tr>
<td>32</td>
<td>Read or write while drive faulted</td>
</tr>
<tr>
<td>33</td>
<td>Write and burst error</td>
</tr>
<tr>
<td>35</td>
<td>Write and write unsafe</td>
</tr>
<tr>
<td>LED Error Code</td>
<td>Error Name</td>
</tr>
<tr>
<td>----------------</td>
<td>--------------------------------------------------------------</td>
</tr>
<tr>
<td>36</td>
<td>R/W head short</td>
</tr>
<tr>
<td>37</td>
<td>Write gate and no write current</td>
</tr>
<tr>
<td>38</td>
<td>Read and multi-chip select error</td>
</tr>
<tr>
<td>39</td>
<td>Write and off track</td>
</tr>
<tr>
<td>3A</td>
<td>Write and write protect</td>
</tr>
<tr>
<td>3B</td>
<td>R/W-HDA-servo-hybrid interlock error</td>
</tr>
<tr>
<td>3C</td>
<td>Hybrid-servo interlock error</td>
</tr>
<tr>
<td>3D</td>
<td>Hybrid-read/write interlock error</td>
</tr>
<tr>
<td>3E</td>
<td>Hybrid-OCP interlock error</td>
</tr>
<tr>
<td>40</td>
<td>Invalid R/W memory region specified</td>
</tr>
<tr>
<td>41</td>
<td>Response timeout error</td>
</tr>
<tr>
<td>42</td>
<td>Seek command received when drive not online</td>
</tr>
<tr>
<td>43</td>
<td>Level-1 SDI command while no R/W ready</td>
</tr>
<tr>
<td>46</td>
<td>R/W safety interrupt with no &quot;cause&quot; bits set</td>
</tr>
<tr>
<td>47</td>
<td>Incorrect TT bit during disconnect command</td>
</tr>
<tr>
<td>48</td>
<td>Invalid write memory offset or byte count</td>
</tr>
<tr>
<td>49</td>
<td>Invalid command during topology mode</td>
</tr>
<tr>
<td>4A</td>
<td>Drive disabled by DD bit</td>
</tr>
<tr>
<td>4B</td>
<td>Index pulse error</td>
</tr>
<tr>
<td>4D</td>
<td>Write and bad embedded</td>
</tr>
<tr>
<td>4E</td>
<td>Write or format command received while drive write-protected</td>
</tr>
<tr>
<td>4F</td>
<td>SDI transmission/transfer error</td>
</tr>
<tr>
<td>50</td>
<td>Slave diagnostic timeout</td>
</tr>
<tr>
<td>51</td>
<td>Sector/byte counter &quot;count&quot; error</td>
</tr>
<tr>
<td>54</td>
<td>Head select register test error</td>
</tr>
<tr>
<td>57</td>
<td>Faulty hybrid timer</td>
</tr>
<tr>
<td>58</td>
<td>Missing index or sector pulse fault</td>
</tr>
<tr>
<td>LED Error Code</td>
<td>Error Name</td>
</tr>
<tr>
<td>----------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>60</td>
<td>R/W test, head select error</td>
</tr>
<tr>
<td>61</td>
<td>R/W test, data setup error</td>
</tr>
<tr>
<td>62</td>
<td>Read test, overall failure</td>
</tr>
<tr>
<td>63</td>
<td>Read test, partial failure</td>
</tr>
<tr>
<td>65</td>
<td>R/W test, sector sync timeout error</td>
</tr>
<tr>
<td>66</td>
<td>Read and off track</td>
</tr>
<tr>
<td>67</td>
<td>Write test not executable</td>
</tr>
<tr>
<td>69</td>
<td>R/W test, faulty data detect error</td>
</tr>
<tr>
<td>6F</td>
<td>Diagnostic write attempt while write-protected</td>
</tr>
<tr>
<td>7B</td>
<td>Internal test cannot run while spindle is spinning</td>
</tr>
<tr>
<td>80</td>
<td>Hybrid ROM consistency fault</td>
</tr>
<tr>
<td>81</td>
<td>SDI wrap test, command available did not reset</td>
</tr>
<tr>
<td>83</td>
<td>SDI wrap test, INIT not received error</td>
</tr>
<tr>
<td>84</td>
<td>SDI wrap test, INIT failed to clear</td>
</tr>
<tr>
<td>85</td>
<td>Hybrid RAM test failure on RAM 0</td>
</tr>
<tr>
<td>87</td>
<td>Hybrid ROM 0 checksum error</td>
</tr>
<tr>
<td>8A</td>
<td>SDI wrap test, bit stuck in SDI error register</td>
</tr>
<tr>
<td>8C</td>
<td>SDI wrap test, SDI transfer error</td>
</tr>
<tr>
<td>8F</td>
<td>Hybrid ROM 1 checksum error</td>
</tr>
<tr>
<td>94</td>
<td>SDI wrap test, command available timeout</td>
</tr>
<tr>
<td>95</td>
<td>SDI wrap test, frame code receive error</td>
</tr>
<tr>
<td>96</td>
<td>SDI wrap test, data byte receive error</td>
</tr>
<tr>
<td>97</td>
<td>Hybrid ROM 2 checksum error</td>
</tr>
<tr>
<td>9E</td>
<td>Hybrid ROMs in wrong sockets</td>
</tr>
<tr>
<td>A0</td>
<td>R/W safety port stuck bit fault</td>
</tr>
<tr>
<td>A2</td>
<td>Failed to fault during forced multi-chip select while reading</td>
</tr>
<tr>
<td>A3</td>
<td>Failed to fault during forced simultaneous read gate and write gate</td>
</tr>
<tr>
<td>LED Error Code</td>
<td>Error Name</td>
</tr>
<tr>
<td>---------------</td>
<td>----------------------------------------------------------------</td>
</tr>
<tr>
<td>A4</td>
<td>Failed to fault during forced write current and no write gate</td>
</tr>
<tr>
<td>A5</td>
<td>Failed to fault during forced write gate and no write current</td>
</tr>
<tr>
<td>A9</td>
<td>Servo fault during R/W forced fault test</td>
</tr>
<tr>
<td>AA</td>
<td>Test completed ok</td>
</tr>
<tr>
<td>B0</td>
<td>Test does not run due to a drive fault</td>
</tr>
<tr>
<td>B3</td>
<td>Hybrid microprocessor bus test error</td>
</tr>
<tr>
<td>B6</td>
<td>USART transmit/receive error</td>
</tr>
<tr>
<td>B8</td>
<td>No stream test write clock</td>
</tr>
<tr>
<td>B9</td>
<td>No stream ECL read clock</td>
</tr>
<tr>
<td>BA</td>
<td>No stream buffered servo clock</td>
</tr>
<tr>
<td>BB</td>
<td>No stream ECL write data</td>
</tr>
<tr>
<td>BC</td>
<td>No stream encoded write data</td>
</tr>
<tr>
<td>BD</td>
<td>No stream decoded read data</td>
</tr>
<tr>
<td>BE</td>
<td>No stream ECL read data</td>
</tr>
<tr>
<td>BF</td>
<td>Stream flip-flop reset error</td>
</tr>
<tr>
<td>C0</td>
<td>Fine track timer error</td>
</tr>
<tr>
<td>C1</td>
<td>Fine track status not true error</td>
</tr>
<tr>
<td>C2</td>
<td>Fine track status not false error</td>
</tr>
<tr>
<td>C3</td>
<td>Fine track over range error</td>
</tr>
<tr>
<td>C4</td>
<td>Fine track under range error</td>
</tr>
<tr>
<td>C5</td>
<td>Wrong fine track channel detected</td>
</tr>
<tr>
<td>C6</td>
<td>PLO error</td>
</tr>
<tr>
<td>C8</td>
<td>ADC/DAC reference voltage out of range</td>
</tr>
<tr>
<td>C9</td>
<td>ADC/DAC bit error</td>
</tr>
<tr>
<td>CA</td>
<td>ADC/ODAC bit error</td>
</tr>
<tr>
<td>CC</td>
<td>Difference counter load error</td>
</tr>
<tr>
<td>CD</td>
<td>Difference counter &quot;count&quot; error or incorrect gray code bits</td>
</tr>
<tr>
<td>LED Error Code</td>
<td>Error Name</td>
</tr>
<tr>
<td>----------------</td>
<td>------------------------------------------------</td>
</tr>
<tr>
<td>CE</td>
<td>Servo sanity timer error</td>
</tr>
<tr>
<td>D0</td>
<td>Head load attempt failed</td>
</tr>
<tr>
<td>D1</td>
<td>Outer guard band status error after load</td>
</tr>
<tr>
<td>D2</td>
<td>Inner guard band status error after load</td>
</tr>
<tr>
<td>D3</td>
<td>Seek into outer guard band failed</td>
</tr>
<tr>
<td>D4</td>
<td>Outer guard band false after outer guard band seek</td>
</tr>
<tr>
<td>D5</td>
<td>Load from outer guard band failed</td>
</tr>
<tr>
<td>D6</td>
<td>Spindle not up to speed</td>
</tr>
<tr>
<td>D7</td>
<td>Seek into inner guard band failed</td>
</tr>
<tr>
<td>D8</td>
<td>Inner guard band false after inner guard band seek</td>
</tr>
<tr>
<td>D9</td>
<td>Load from inner guard band failed</td>
</tr>
<tr>
<td>DA</td>
<td>Spindle not spinning</td>
</tr>
<tr>
<td>DB</td>
<td>Diagnostic seek failed</td>
</tr>
<tr>
<td>DC</td>
<td>F.E. diagnostic set up error</td>
</tr>
<tr>
<td>DD</td>
<td>Recalibration error</td>
</tr>
<tr>
<td>DE</td>
<td>Low velocity seek error</td>
</tr>
<tr>
<td>E0</td>
<td>Random seek error</td>
</tr>
<tr>
<td>E2</td>
<td>Slave ROM consistency error</td>
</tr>
<tr>
<td>E3</td>
<td>Slave ROM 0 checksum error</td>
</tr>
<tr>
<td>E4</td>
<td>Slave ROM 1 checksum error</td>
</tr>
<tr>
<td>E5</td>
<td>Slave ROM 2 checksum error</td>
</tr>
<tr>
<td>E6</td>
<td>Slave ROM 3 checksum error</td>
</tr>
<tr>
<td>E7</td>
<td>A diagnostic test is executing</td>
</tr>
<tr>
<td>E8</td>
<td>RAM test error on servo RAM 0</td>
</tr>
<tr>
<td>E9</td>
<td>RAM test error on servo RAM 1</td>
</tr>
<tr>
<td>EE</td>
<td>Non-existent test number specified</td>
</tr>
<tr>
<td>F1</td>
<td>Slave load timeout</td>
</tr>
<tr>
<td>LED Error Code</td>
<td>Error Name</td>
</tr>
<tr>
<td>----------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>F2</td>
<td>Slave sent unexpected message</td>
</tr>
<tr>
<td>F3</td>
<td>Slave received command packet with checksum error</td>
</tr>
<tr>
<td>F4</td>
<td>Slave opcode parity error</td>
</tr>
<tr>
<td>F5</td>
<td>Slave received invalid opcode</td>
</tr>
<tr>
<td>F6</td>
<td>Master detected checksum error from slave</td>
</tr>
<tr>
<td>F7</td>
<td>Slave recalibration timeout</td>
</tr>
<tr>
<td>F8</td>
<td>Slave seek timeout</td>
</tr>
<tr>
<td>F9</td>
<td>Slave offset timeout</td>
</tr>
<tr>
<td>FA</td>
<td>Slave spin-up timeout</td>
</tr>
<tr>
<td>FB</td>
<td>Slave spin-down timeout</td>
</tr>
<tr>
<td>FC</td>
<td>Slave send status timeout</td>
</tr>
<tr>
<td>FE</td>
<td>Slave speed check timeout</td>
</tr>
<tr>
<td>FF</td>
<td>Slave disable embedded servo timeout</td>
</tr>
</tbody>
</table>
## Static Control Materials Part Number List

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>29-25435-00</td>
<td>ESD demonstration kit 110V</td>
</tr>
<tr>
<td>29-25433-00</td>
<td>ESD demonstration kit 220V</td>
</tr>
<tr>
<td>29-11762-00</td>
<td>Velostat FS grounding kit (complete) includes</td>
</tr>
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<td>29-25492-00</td>
<td>10 foot coil cord (for wrist strap)</td>
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<td>Velostat FS work surface</td>
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<td>29-25494-00</td>
<td>Insulated alligator clip</td>
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<td>29-25496-00</td>
<td>Wrist strap, small</td>
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<td>29-25497-00</td>
<td>Wrist strap, medium</td>
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<td>29-25498-00</td>
<td>Wrist strap, large</td>
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<td>99-07092-01</td>
<td>Static shielding bag, 4 inches x 6 inches I.D.</td>
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<td>99-07092-02</td>
<td>Static shielding bag, 6 inches x 8 inches I.D.</td>
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<td>99-07092-03</td>
<td>Static shielding bag, 8 inches x 12 inches I.D.*</td>
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<td>99-07092-04</td>
<td>Static shielding bag, 10 inches x 14 inches I.D.</td>
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<td>99-07092-05</td>
<td>Static shielding bag, 12 inches x 18 inches I.D.</td>
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<td>Static shielding bag, 14 inches x 18 inches I.D.**</td>
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<td>Static shielding bag, 18 inches x 24 inches I.D.</td>
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<td>Static shielding bag, 15 inches x 20 inches I.D.</td>
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* Minimum size shielding bag required for read/write module or operator control panel (OCP) module.

** Minimum size shielding bag required for RA82 hybrid module or servo module.
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