HEWLETT PACKARD

HP DDS Drives

User Manual

Notice

The information contained in this document is subject to change without notice.

Printing History

Version	Date	Changed Pages
Edition 1	June 94	All
Edition 2	November 94	Minor updates
Edition 3	May 95	Cosmetic changes
Draft Edition 4	Nov 95	Addition of HP C1537A and HP C1553A
Draft Edition 5	July 1996	Addition of HP C1539A
Edition 6	September 1996	Addition of HP C1557A
Edition 6.1	March 1997	Changed MTBF for HP C1553A (p.9-2). Changed duty cycle for HP C1557A. (p.9-2). Tolerances and dimensions on Figure 2.8 changed slightly. Inclusion of supported Mode and Log pages (p.7-5).
Edition 6.2	October 1997	Small changes
Edition 6.3	May 1998	Small changes
Edition 7	May 1999	Addition of HP C5683A, HP C5713A and HP C1536A
Edition 8	December 1999	Small changes

Note

As far as this manual is concerned:
■ the HP C1554A is identical to the HP C1537A
■ the HP C1599A is identical to the HP C1539A
■ the HP C5648A is identical to the HP C1557A
■ the HP C5737A is identical to the HP C1536A

The inclusion of a particular drive or autoloader in this document does not imply that that drive or autoloader is currently available.

The Purpose of this Manual

This manual provides a comprehensive introduction to HP DDS drives:

- HP C1534A DDS-1 Drive, with a capacity of 2 gigabytes
- HP C1536A (HP C5737A) DDS-1 Drive, with a capacity of 4 gigabytes using 2:1 data compression
- HP C1533A DDS-2 Drive, with a capacity of 8 gigabytes using 2:1 data compression
- HP C1539A (HP C1599A) DDS-2 Drive, with a capacity of 8 gigabytes using 2:1 data compression
- HP C1553A DDS-2 Autoloader, with a capacity of 48 gigabytes using 2:1 data compression
- HP C1537A (HP C1554A) DDS-3 Drive, with a capacity of 24 gigabytes using 2:1 data compression
- HP C1557A (HP C5648A) DDS-3 Autoloader, with a capacity of 144 gigabytes using 2:1 data compression
- HP C5683A DDS-4 Drive, with a capacity of 40 gigabytes using 2:1 data comprssion
- HP C5713A DDS-4 Autoloader, with a capacity of 240 gigabytes using 2:1 data compression

It gives details of how to install and operate the drives, and contains full specifications of all the drives.

Further information is available in volumes 2–5 of the HP DDS Technical Manual:

- Volume 2: Integration Guide
- Volume 3: The SCSI Interface
- Volume 4: Background to DDS Products
- Volume 5: DDS UNIX Configuration Guide

See Chapter 1 for details of these and other documents.

Contents

1

Introduction

HP DDS Drives

HP C1553A, HP C1557A, HP C5713A autoloader mechanisms
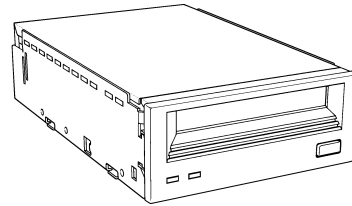
HP C1533A, HP C1534A, HP C1536A, HP C1537A, HP C1539A, HP C5683A drive mechanisms

The family of DDS drives from HP is outlined in the following table.

	HP C1534A	HP C1536A (HP C5737A)	HP C1533A	HP C1537A (HP C1554A)	HP C1539A (HP C1599A)	HP C1553A	HP C1557A (HP C5648A)	HP C5683A	HP C5713A
Size	3½″ HH	3½″ HH	3½″ HH	3½″ HH	3½″ HH	5¼″ FH	5¼″ FH	3½″ HH	5¼″ FH
Format	DDS-1	DDS-DC	DDS-2	DDS-3	DDS-2	DDS-2	DDS-3	DDS-4	DDS-4
DCLZ Data Compression	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Capacity *(with 2:1 data compression where supported)*									
DDS-1 60m:	1.3 GB	2.6 GB	2.6 GB	2.6 GB	2.6 GB	15.6 GB	15.6 GB	n/s	n/s
DDS-1 90m:	2.0 GB	4.0 GB	4.0 GB	4.0 GB	4.0 GB	24 GB	24.0 GB	4.0 GB*	24 GB*
DDS-2 120m:	n/s	n/s	8.0 GB	8.0 GB	8.0 GB	48 GB	48.0 GB	8.0 GB	48 GB
DDS-3 125m:	n/s	n/s	n/s	24.0 GB	n/s	n/s	144.0 GB	24.0 Gb	144 GB
DDS-4 150m	n/s	n/s	n/s	n/s	n/s	n/s	n/s	40.0 Gb	240 GB
Maximum Sustained Transfer Rate									
no compression:	183 KB/s	183 KB/s	510 KB/s	1 MB/s	510 KB/s	510 KB/s	1 MB/s	3 MB/s	3 MB/s
2:1 compression:	n/s	366 KB/s	1.02 MB/s	2 MB/s	1.02 MB/s	1.02 MB/s	2 MB/s	6 MB/s	6 MB/s
Error Rate	<1 in 10^{15}	<1 in 10^{15}	<1 in 10^{15}	<1 in 10^{15}	<1 in 10^{15}	<1 in 10^{15}	<1 in 10^{15}	<1 in 10^{15}	<1 in 10^{15}
Data Buffer	512 KB	512 KB	1 MB	2 MB	1 MB	1 MB	2 MB	8 MB	8 MB
Firmware upgrade via SCSI or cartridge	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Read-after-write (RAW)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Interface									
SE narrow SCSI-2:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Ultra-wide LVD and SE multi-mode SCSI:	No	No	No	No	No	No	No	No	No
MTBF Hours:	200,000	200,000	200,000	200,000	300,000	40,000	55,000	400,000	100,000
Duty cycle:	5%	5%	12%	12%	12%	30%	30%	12%	30%

n/s = not supported   SE = Single-Ended

DDS Formats and Compatibility

DDS formats have been developed by Hewlett-Packard for data storage drives which use and build on DAT technology. DDS-format drives are produced by a number of manufacturers.

HP C1534A

The HP C1534A implements the DDS-1 format. This incorporates the error correction techniques used in audio DAT drives with additional techniques specifically designed to provide the integrity of data necessary for computer use. These extra methods of error detection and correction are as follows:

❏ C3 ECC, a third level of Error Correction Code, providing correction across frames within groups.
❏ Read-After-Write, where data is verified immediately after it is written and re-written if there is any error.
❏ Data Randomizer, for recoding the data in order to provide a consistent signal level. This enables read-after-write to be effective.
❏ Track checksums, for detecting and locating helical errors, and so improving the performance of C3 ECC.
❏ N-Group Writing, where every group is repeated a set number of times. The default setting for N is 1.

Each tape can be formatted as a single data space, or as two partitions which can be written to independently.

Tapes are used as follows:

DDS-1 60m	DDS-1 90m	DDS-2	DDS-3	DDS-4
DDS-1	DDS-1	not supported	not supported	not supported

HP C1536A (HP C5737A)

The HP C1536A implements the DDS-DC format. This includes all of the features of the DDS-1 format, plus an extension to include data compression as follows:

❏ Compressed data can be stored in a way that maintains the full functionality of the DDS format, and ensures backwards compatibility with existing DDS drives.
❏ Any DDS-1 and DDS-DC cartridge can be read, whether data compression is switched on or off.
❏ Data is automatically decompressed on reading even if data compression is switched off.
❏ Mixing compressed and uncompressed data is supported. This means that a cartridge can be written with uncompressed data and read in any DDS drive.

Tapes are used as follows:

DDS-1 60m	DDS-1 90m	DDS-2	DDS-3	DDS-4
DDS-1	DDS-1	not supported	not supported	not supported

HP C1533A and HP C1539A (HP C1599A)

The HP C1533A and HP C1539A implement the DDS-2 format. This includes all of the features of the DDS-1 and DDS-DC formats, plus the ability to read and write with much higher capacity when using DDS-2 cartridges. The drives read and write using DDS-1 format when using DDS-1 media (60m and 90m).

The HP C1539A has a TapeAlert feature that allows software and operating systems to warn users of problems which may occur, such as a cartridge nearing the end of its useful life, and to recommend actions that the user can take to recover from the situation. The drive also has an improved internal cleaning sweeper that reduces the frequency of cleaning tape usage by a factor of eight.

Tapes are used as follows:

DDS-1 60m	DDS-1 90m	DDS-2	DDS-3	DDS-4
DDS-1	DDS-1	DDS-2	not supported	not supported

HP C1553A

The HP C1553A DDS-2 Autoloader combines a changer mechanism with an HP C1533A DDS-2 tape drive mechanism. The autoloader houses up to six DDS cartridges in a removable magazine, which enables you to back up 48 gigabytes of data overnight (assuming a data compression ratio of 2:1). High-speed file retrieval and tape swapping typically allows access to any file in an average of ninety seconds.

The autoloader supports both sequential and random access mode, with minimum interruption time between cartridges.

The embedded drive has the features listed for the HP C1533A above. The autochanger adds the following:

❏ A Liquid Crystal Display (LCD) giving clear and comprehensive indications of the status of the autoloader
❏ A low-cost magazine carrying up to six DDS cartridges, giving a magazine capacity of 48 gigabytes for DDS-2 cartridges and 2:1 data compression
❏ Compatibility with the SCSI-2 Medium Changer command set
❏ A common SCSI-2 interface for the drive and changer
❏ A standard 5¼-inch full-height form factor

Tapes are used as follows:

DDS-1 60m	DDS-1 90m	DDS-2	DDS-3	DDS-4
DDS-1	DDS-1	DDS-2	not supported	not supported

HP C1537A (HP C1554A)

The HP C1537A implements the DDS-3 format which allows storage of 24 gigabytes on a DDS-3 tape (assuming a data compression ratio of 2:1). The drive includes most of the features of DDS-2 drives, with the following major differences:

❏ Any DDS-1, DDS-DC, DDS-2 or DDS-3 cartridge can be read or written to, whether data compression is switched on or off.
❏ N-Group writing is no longer supported.
❏ The drive is capable of additional sophisticated techniques of error-correction for dealing with tapes which are not up to specification.

❑ When using DDS-3 media, the drive reads and writes the DDS-3 format with much higher capacity.

❑ An improved internal cleaning sweeper reduces the frequency of cleaning the heads by a factor of eight.

❑ HP's TapeAlert feature allows software and operating systems to warn users of problems which may occur, such as a cartridge nearing the end of its useful life, and to recommend actions that the user can take to recover from the situation.

Tapes are used as follows:

DDS-1 60m	DDS-1 90m	DDS-2	DDS-3	DDS-4
DDS-1	DDS-1	DDS-2	DDS-3	not supported

HP C1557A (HP C5648A)

The HP C1557A DDS-3 Autoloader combines a changer mechanism with an HP C1537A DDS-3 tape drive mechanism. The autoloader houses up to six DDS cartridges in a removable magazine, which enables you to back up 144 gigabytes of data overnight (assuming a data compression ratio of 2:1). High-speed file retrieval and tape swapping typically allows access to any file in an average of ninety seconds.

The autoloader supports both sequential and random access mode, with minimum interruption time between cartridges.

The embedded drive has the features listed for the HP C1537A above. The autochanger adds the following:

❑ A Liquid Crystal Display (LCD) giving clear and comprehensive indications of the status of the autoloader

❑ A low-cost magazine carrying up to six DDS cartridges, giving a magazine capacity of 144 gigabytes for DDS-3 cartridges and 2:1 data compression

❑ Compatibility with the SCSI-2 Medium Changer command set

❑ A common SCSI-2 interface for the drive and changer

❑ A standard 5¼-inch full-height form factor

Tapes are used as follows:

DDS-1 60m	DDS-1 90m	DDS-2	DDS-3	DDS-4
DDS-1	DDS-1	DDS-2	DDS-3	not supported

HP C5683A

The HP C5683A implements the DDS-4 format which allows storage of 40 gigabytes on a DDS-4 tape (assuming a data compression ratio of 2:1). The drive includes most of the features of DDS-3 drives, with the following major differences:

❑ Any DDS-2, DDS-3 or DDS-4 cartridge can be read or written to, whether data compression is switched on or off. 90m DDS-1 tapes can be read but not written to.

❑ Wide Fast-20 LVD Ultra SCSI interface.

❑ New three-point mechanism mounting system.

Tapes are used as follows:

DDS-1 60m	DDS-1 90m	DDS-2	DDS-3	DDS-4
nor supported	DDS-1 read only	DDS-2	DDS-3	DDS-4

HP C5713A

The HP C5713A DDS-4 Autoloader combines a changer mechanism with an HP C5683A DDS-4 tape drive mechanism. The autoloader houses up to six DDS cartridges in a removable magazine, which enables you to back up 240 gigabytes of data overnight (assuming a data compression ratio of 2:1). High-speed file retrieval and tape swapping typically allows access to any file in an average of ninety seconds.

The embedded drive has the features listed for the HP C5683A above. The autochanger adds the following:

❏ A Liquid Crystal Display (LCD) giving clear and comprehensive indications of the status of the autoloader
❏ A low-cost magazine carrying up to six DDS cartridges, giving a magazine capacity of 240 gigabytes for DDS-4 cartridges and 2:1 data compression
❏ Compatibility with the SCSI-2 Medium Changer command set
❏ A common SCSI-2 interface for the drive and changer
❏ A standard 5¼-inch full-height form factor

Tapes are used as follows:

DDS-1 60m	DDS-1 90m	DDS-2	DDS-3	DDS-4
nor supported	DDS-1 read only	DDS-2	DDS-3	DDS-4

Related Documents

The following documents provide additional information:

Documents Specific to HP DDS Drives

■ *HP DDS Technical Manual, Vol.2 "Integration Guide"*, part no. C1533-90906
■ *HP DDS Technical Manual, Vol.3 "The SCSI Interface"*, part no. C1533-90907
■ *HP DDS Technical Manual, Vol.4 "Background to DDS Products"*, part no. C1533-90908
■ *HP DDS Technical Manual, Vol.5 "HP DDS Configuration Guide"*, part no. C1533-90915

Contact your HP supplier for copies.

General Documents and Standardization

■ *Small Computer System Interface (SCSI-1)*, ANSI X3.131-1986. The ANSI authorized standard for SCSI implementation, available through ANSI
■ *Enhanced Small Computer System Interface (SCSI-2)*
  ANSI X3T9.2-1993 Rev. 10L, available through ANSI
■ DDS-1
  ❏ ECMA-170
  ❏ ISO/IEC 12247:1993
  ❏ ANSI X3.203 and X3.206
■ DDS-DC
  ❏ ECMA-150, 2nd Edition
  ❏ ISO/IEC 11557:1992

- DCLZ
  - ECMA-151, 2nd Edition
  - ISO/IEC 11558:1992
  - ANSI X3.223
- DDS-2
  - ECMA-198, 2nd Edition
  - ISO/IEC 13923:1995
- DDS-3
  - ECMA-236, 1st Edition
- DDS-4
  - ECMA-288, 1st Edition

Copies of General Documents can be obtained from:

ANSI	11 West 42nd Street New York, NY 10036-8002 USA	
ISO	CP 56 CH-1211 Geneva 20 Switzerland	
ECMA	114 Rue du Rhône CH-1204 Geneva Switzerland	*Tel:* +41 22 849 6000 Web URL: `http://.www.ecma.ch`
Global Engineering Documents	2805 McGaw Irvine, CA 92714 USA	*Tel:* 800 854 7179 or 714 261 1455

Ordering Supplies

Part number for supplies are as follows:

C5718A	150m DDS-4 Media Recognition System cartridge
C5708A	125m DDS-3 Media Recognition System cartridge
C5707A	125m DDS-2 Media Recognition System cartridge
C5706A	90m DDS-1 Media Recognition System cartridge
C5705A	60m DDS-1 Media Recognition System cartridge
C5709A	Cleaning cartridge
92283L	Lockable storage box for 12 cartridges
C1571A	Magazine for the HP C1553A, HP C1557A and HP C5713A autoloaders
C1572A	Autoloader magazine complete with five DDS-2 cartridges and one cleaning cartridge
C15570	Autoloader magazine complete with five DDS-3 cartridges and one cleaning cartridge
C7436A	Autoloader magazine complete with five DDS-4 cartridges and one cleaning cartridge

SCSI Accessories:

92222A	SCSI interface cable: low to low density connectors—0.5m
92222B	SCSI interface cable: low to low density connectors—1.0m
92222C	SCSI interface cable: low to low density connectors—2.0m
K2296	SCSI interface cable: high to low density connectors—0.9m
K2297	SCSI interface cable: high to low density connectors—1.5m
C5743A	SCSI interface cable: 68-pin high to 68-pin high density connectors, LVD/SE Ultra2 quality conductors (for DDS-4 drives)—2.5m
C5742A	SCSI interface cable: 68-pin high to 68-pin high density connectors, LVD/SE Ultra2 quality conductors (for DDS-4 drives)—1.5m
C5741A	SCSI interface cable: 68-pin high to 68-pin high density connectors, LVD/SE Ultra2 quality conductors (for DDS-4 drives)—0.9m
C7424A	Internal SCSI cable: 4 connector, 68-way, terminated, LVD/SE Ultra2 quality conductor (for DDS-4 drives)—1m (the connector comes as part of the cable)
92222D	SCSI extender cable
1252-3251	SCSI bus passive terminator*
K2291	SCSI bus active terminator*
1252-5634	SCSI bus SLICK active terminator (for HP NetServers)

*You should use active termination on the SCSI bus for devices which support a transfer rate of more than 5 MB/s, or when there is any such device on the bus. It is possible to use HP DDS drives at 5 MB/s in which case passive termination is a possibility. However, HP recommends that you use of active termination in all cases.

2

Installation

Power Connection

The power connections are shown in figures 2.1 and 2.3 for drives and figures 2.2 and 2.4 for autoloaders.

Figure 2.1 Power connections (pre-DDS-4 drives)

Rear of Drive

+5V
+5V gnd
+12V
+12V gnd
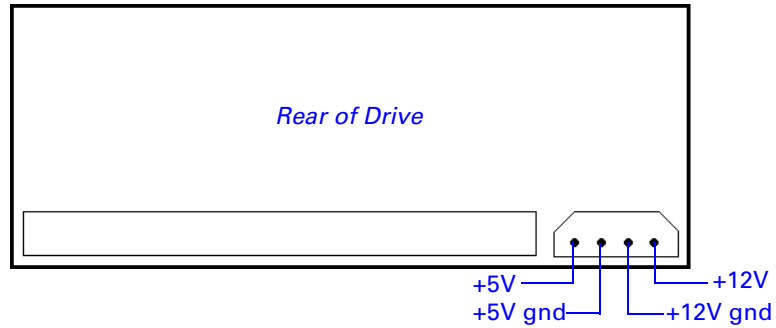
Figure 2.2 Power connections (pre-DDS-4 autoloaders)

Autoloader option switches

+5V
+5V gnd
+12V gnd
+12V

Changer power

Rear of the embedded drive

Drive power +5V
+5V gnd
+12V
+12V gnd
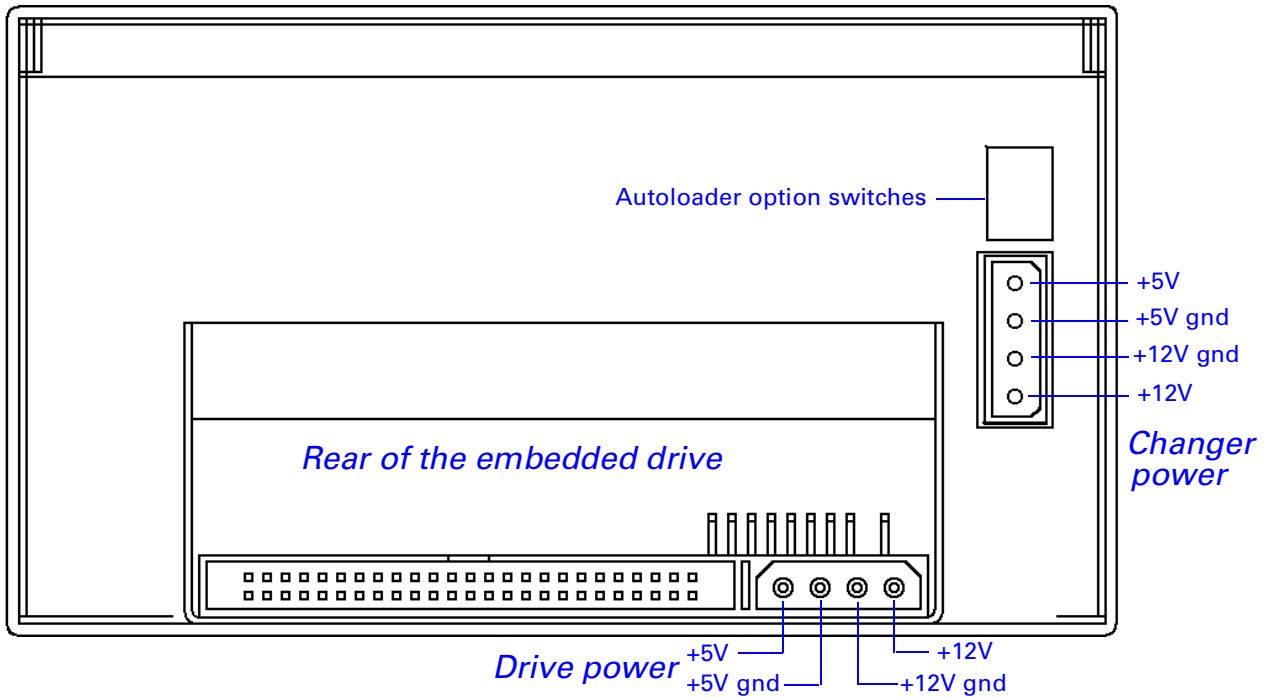
Figure 2.3 Power connections (DDS-4 drives)

Rear of Drive

+5V
+5V gnd
+12V
+12V gnd
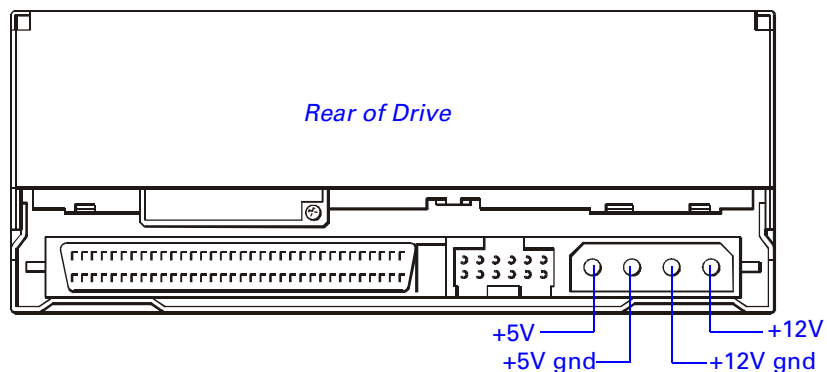
Figure 2.4 Power connections (pre-DDS-4 autoloaders)

Autoloader option switches

+5V
+5V gnd
+12V gnd
+12V

Rear of the embedded drive

Changer power

Drive power +5V
+5V gnd
+12V
+12V gnd
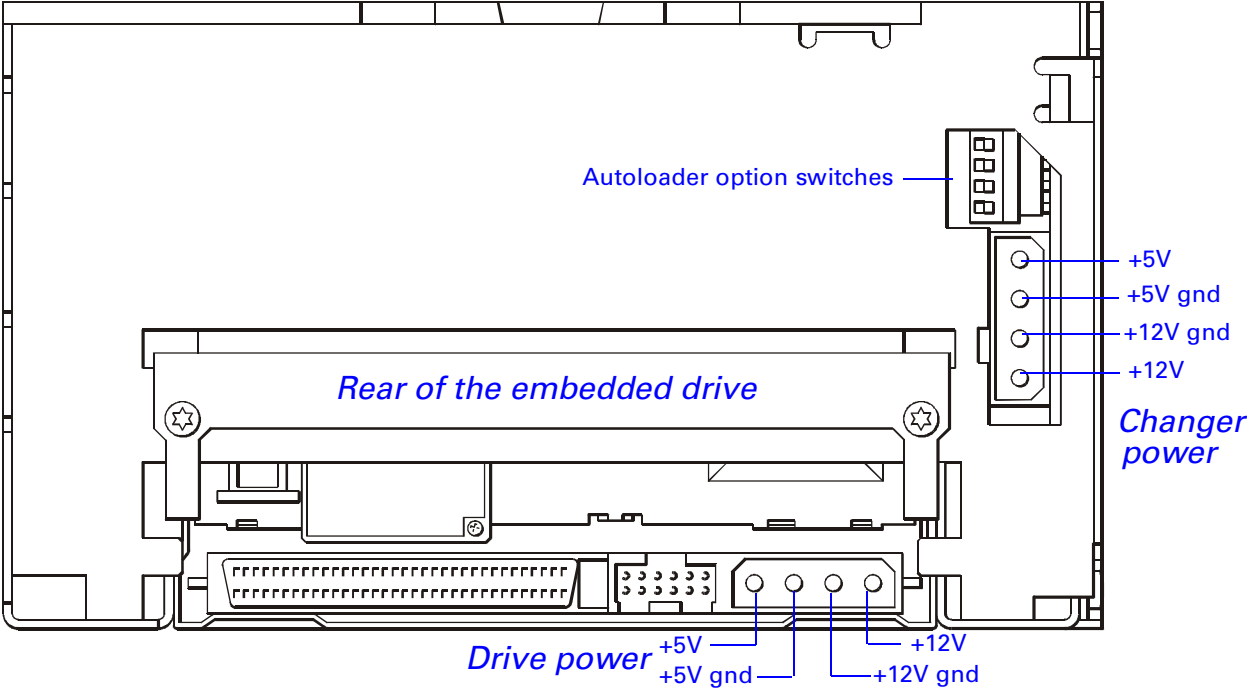
Figure 2.5 Y-cord connections

Changer   Drive

5V Gnd Gnd 12V   5V Gnd Gnd 12V

5V Gnd Gnd 12V

+5V Gnd +12V
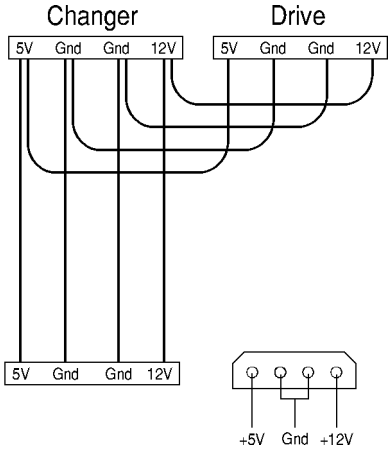
For autoloaders, connect power by using the Y-Cord connector shown in figure 2.5, which is supplied with the autoloader. Note that the two ground lines are routed separately, and only connected together to a common ground at the external power supply connector.

Grounding

The 5V and 12V grounds are both connected to the chassis.

The following are appropriate parts to make up a mating connector:

Housing	AMP part number 1-480424-0
Pins for 18 AWG cable	AMP part number 60619-4 (quantity 4)

SCSI Connection and Termination (DDS-1 drives only)

Only a single-ended, narrow SCSI configuration is supported. The hardware and termination specifications of this interface type can be found in Section 4, Physical Characteristics, of the SCSI X3T9/89-042 Standard.

Only unshielded connectors can be used.

The HP C1534A and HP C1536A do not support termination on the drive itself. Normally, drives such as these are not required to be at the end of a bus, but if this is unavoidable, HP recommends the use of an additional short length of cable with a terminator attached. There is not enough space for a feed-through connector to be connected to the drive, unless you use a special short modified power extender cable with one ear reduced.

The following are possible cable and terminator sources:

Cable:	28AWG Ribbon, Spectra Strip	132-2899-887 style 2697
Connector:	3M Connector	3425-7650
	3M Strain Relief	3448-3050
Power Extender:	4-way Feed-Through Power Cable	C1534-61001
Terminator:	Methode Active SCSI Terminator	DM 1050-02-R
	Methode Passive SCSI Terminator	DM 1050-02-O

Setting the SCSI ID

The SCSI ID is set using jumpers on the set of pins beside the SCSI connector at the rear of the drive, as shown in figure 2.6.

Figure 2.6 Rear panel of the HP C1534A/36A
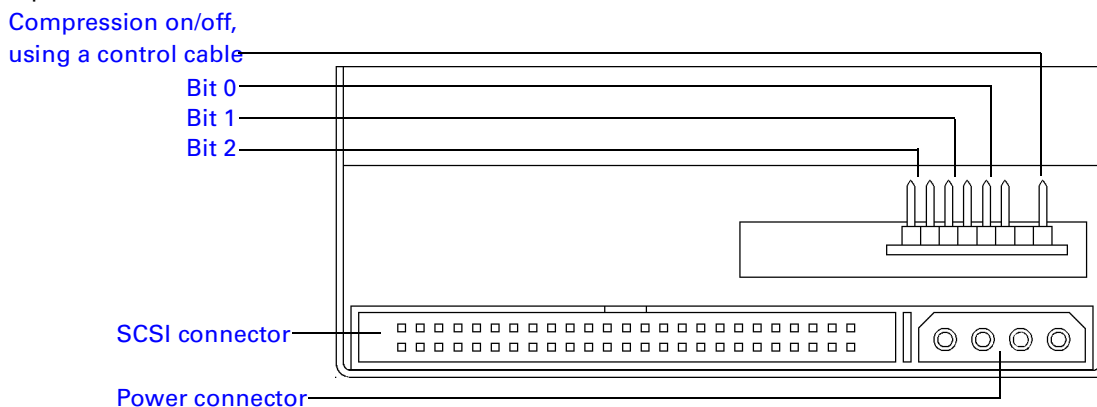
The three significant bits in the ID give a range of 0 through 7 as follows:

SCSI ID	Bit 2	Bit 1	Bit 0
0	0	0	0
1	0	0	1
2	0	1	0
3	0	1	1

SCSI ID	Bit 2	Bit 1	Bit 0	
4	1	0	0	1=shorted
5	1	0	1	0=open
6	1	1	0	
7	1	1	1	

The HP C1534A/36A reads the SCSI ID at power-up and during self-test.

Data Compression Control

For the HP C1536A, data compression can be controlled through the jumper pin shown in figure 2.6. The HP C1534A does not support data compression.

The pin is only monitored at power-on, and controls whether data compression is enabled by default. Any subsequent change to the pin is ignored.

Pin State	Effect
Unconnected *(default)*	Data compression is only controlled by configuration switches 1 and 2 (on the underside of the drive) and through MODE SELECT.
Connected to 0V	Data compression is disabled. The setting of configuration switch 1 is ignored. Switch 2 is valid. Data compression can still be controlled through MODE SELECT. Note that when reading, the drive will decompress compressed data.

It follows, that if you are using this pin, you should set configuration switch 1 on the underside of the drive to ON.

Termination Power

The HP C1534A and HP C1536A are permanently configured to provide termination power.

SCSI Connection and Termination (DDS-2 and DSS-3 drives only)

Only a single-ended, narrow SCSI configuration is supported, with a maximum sustained transfer rate of 8 MB/s. See Section 4, Physical Characteristics, of the SCSI X3T9/89-042 Standard. Only use unshielded connectors.

The drive does not support termination on the device itself. Normally, drives such as this are not required to be at the end of a bus, but if this is unavoidable, HP recommends the use of the feed-through SCSI terminator listed below, which plugs directly into the rear of the drive. Use active termination because the drive is capable of a transfer rate greater than 5 MB/s.

The following are possible cable and terminator sources:

Cable:	28AWG Ribbon, Spectra Strip	132-2899-887 style 2697
Connector:	3M Connector	3425-7650
	3M Strain Relief	3448-3050
Terminator:	Methode Active SCSI Terminator	DM550-06-R
	Amphenol Active SCSI Terminator	33770

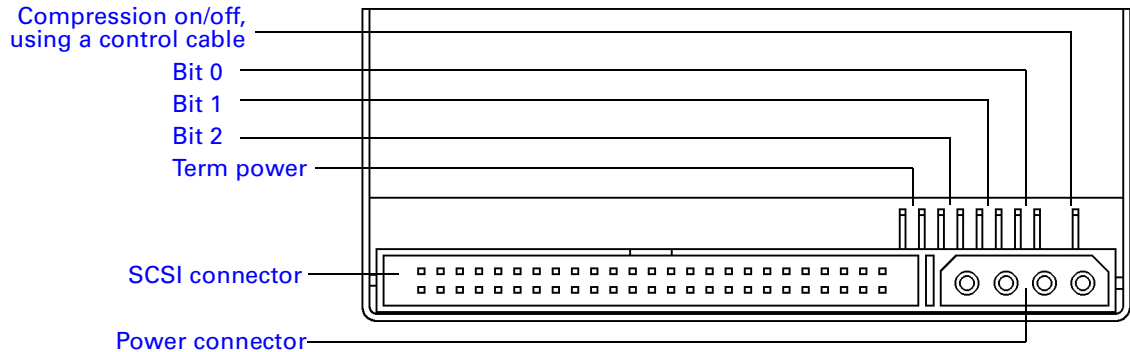**Note** When using feed-through termination, termination power *must* be supplied to pin 26 of the SCSI Interface. Power can be supplied by any device on the bus. If you want the drive to supply it, set a jumper across the two pins marked "Term power" in figure 2.7.

Be careful when inserting and removing feed-through terminators, to avoid damaging the end walls of the terminator and the drive.

Setting the SCSI ID

The SCSI ID is set using jumpers on the set of pins beside the SCSI connector at the rear of the drive, as shown in figure 2.7.

Figure 2.7 Rear panel of the HP C1533A/37A/39A

The three significant bits in the ID give a range of 0 through 7 as follows:

SCSI ID	Bit 2	Bit 1	Bit 0
0	0	0	0
1	0	0	1
2	0	1	0
3	0	1	1

SCSI ID	Bit 2	Bit 1	Bit 0
4	1	0	0
5	1	0	1
6	1	1	0
7	1	1	1

1=shorted
0=open

The drive reads the SCSI ID at power-up and during self-test.

Data Compression Control

Data compression can be controlled through the jumper pin shown in figure 2.7.

The pin is only monitored at power-on, and controls whether data compression is enabled by default. Any subsequent change to the pin is ignored.

Pin State	Effect
Unconnected *(default)*	Data compression is controlled by configuration switches 1 and 2 (on the underside of the drive) and through the SCSI MODE SELECT command.
Connected to 0V	Data compression is disabled. The setting of configuration switch 1 is ignored. Switch 2 is valid. However, data compression can still be controlled through MODE SELECT. Note that when reading, the drive will always decompress compressed data.

It follows from this that if you want to use this pin, you should set configuration switch 1 on the underside of the drive to ON.

Termination Power

The drive will provide termination power for the SCSI termination resistors if a jumper is set across the two pins marked "Term power" in figure 2.7.

SCSI Connection and Termination (DDS-4 drives only)

For the HP C5683A and HP C5713A, ultra-wide LVD and single-ended multi-mode SCSI is supported. Only unshielded connectors can be used.

The drive does not support termination on the device itself. Normally, drives such as this are not required to be at the end of a bus, but if this is unavoidable, HP recommends the use of the feed-through SCSI terminator listed below, which plugs directly into the rear of the drive. Use active termination because the drive is capable of a transfer rate greater than 5 MB/s.

The following are possible cable and terminator sources:

Cable:	Internal, 4 connectors, 68-way Ribbon Cable, LVD/SE Ultra 2 quality conductors—1m (the connector comes as part of the cable)	HP C7424A
Connector:	3M Connector	3425-7650
	3M Strain Relief	3448-3050
Terminator:	Methode Datamate SCSI Terminator	DM 2750-01-LVD-SE

Note When using feed-through termination, termination power *must* be supplied to pin 26 of the SCSI Interface. Power can be supplied by any device on the bus. If you want the drive to supply it, set a jumper across the two pins marked "Term power" in figure 2.7.

Be careful when inserting and removing feed-through terminators, to avoid damaging the end walls of the terminator and the drive.

Mixing SE and LVD, Ultra and Ultra2 SCSI Devices

If you combine SE and LVD devices on the same bus, the host bus adapter will automatically switch to single-ended mode and optimum performance for any device on the bus will be at Ultra speeds and cable length. This means that the performance of any Ultra2 devices will drop to that of Ultra devices. All other devices will operate at their optimum speed.

If you connect only LVD devices, the bus will operate in low voltage differential mode and Ultra2 speeds will be enabled. You can use a combination of Ultra and Ultra2 devices. Each device will operate at its optimum speed.

Setting the SCSI ID

The SCSI ID is set using jumpers on the set of pins beside the SCSI connector at the rear of the drive, as shown in figure 2.8.

Figure 2.8 Rear panel of the HP C5683A/C5713A

SCSI connector   Term. power   3 2 1 0   Power connector
Compression on/off, using a control cable   bits
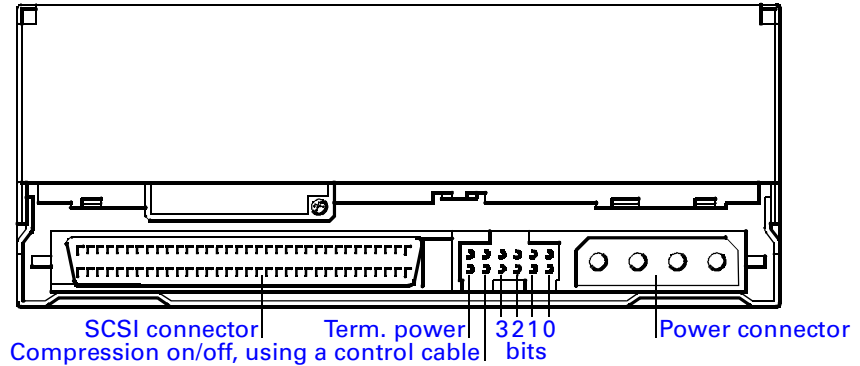
The three significant bits in the ID give a range of 0 through 15 as follows:

SCSI ID	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1

SCSI ID	Bit 3	Bit 2	Bit 1	Bit 0
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1

1=shorted
0=open

The drive reads the SCSI ID at power-up and during self-test.

Data Compression Control

Data compression can be controlled through the jumper pin shown in figure 2.8.

The pin is only monitored at power-on, and controls whether data compression is enabled by default. Any subsequent change to the pin is ignored.

Pin State	Effect
Unconnected *(default)*	Data compression is controlled by configuration switches 1 and 2 (on the underside of the drive) and through the SCSI MODE SELECT command.
Connected to 0V	Data compression is disabled. The setting of configuration switch 1 is ignored. Switch 2 is valid. However, data compression can still be controlled through MODE SELECT. Note that when reading, the drive will always decompress compressed data.

It follows from this that if you want to use this pin, you should set configuration switch 1 on the underside of the drive to ON.

Termination Power

The drive will provide termination power for the SCSI termination resistors if a jumper is set across the two pins marked "Term. power" in figure 2.7.

Configuration Switches

There is a set of configuration switches on the underside of the drive, as shown in figure 2.9. These are read at power-on. With the drive switched off, use the information below to select the correct configuration for your system.

Figure 2.9 Configuration switches (shown in default positions)
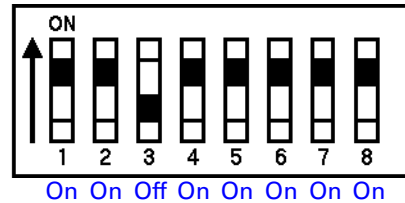
On On Off On On On On On

The following table shows typical Configuration Switch Settings. They are only a rough guideline; there are a great many different settings for different configurations, for example, to enable and disable the Media Recognition System (MRS). The *HP DDS Configuration Guide*, Volume 5 of the HP DDS Technical Manual lists them all and offers configuration advice.

	1	2	3	4	5	6	7	8
Default and most PC Applications	On	On	Off	On	On	On	On	On
Hewlett-Packard Workstations Series 300/400/700/800	On	On	Off	On	On	On	On	On
SUN	On	On	On	On	On	Off	Off	On
IBM RS/6000	On	On	Off	On	On	Off	Off	On
DEC	On	On	Off	On	On	Off	On	Off

Data Compression (not HP C1534A)

(Switches 1 and 2 are disabled in the HP C1534A, because the drive does not support data compression.)

Switches 1 and 2 are normally used to configure the way in which data compression is set for the drive. The following table shows the available options:

Switch 1	Switch 2	Meaning
On	On	Compression enabled at power-on with host control
On	Off	Compression enabled at power-on no host control
Off	On	Compression disabled at power-on. The host is allowed to control compression.
Off	Off	Compression disabled at power-on no host control

Default: (applies to first row)

Note that with switch 1 on, data written to the tape will be compressed without the knowledge of the host.

Media Recognition System (MRS)

Switch 3 is normally used to configure the drive to respond to DDS Media Recognition System tapes. MRS is discussed more fully in Chapter 5.

Switch 3	Meaning
On	The Media Recognition System is disabled. All DDS tapes are treated the same, whether they possess the Media Recognition stripes or not.
Off	MRS is active. Non-Media Recognition System tapes are treated as if they are write-protected.

Default: (row for Off)

Note There is an exception in the case of drives integrated into SUN and IBM systems, where switch 8 controls MRS.

Switches 4 to 8

Switches 4 to 8 are used to specify connectivity and functionality according to host or customer requirements. The default setting is all switches *on*.

Autoloader Option Switches

The autoloader option switches are on the rear-panel (see figure 2.10). The switches are read at power-on.

Figure 2.10 Autoloader option switches
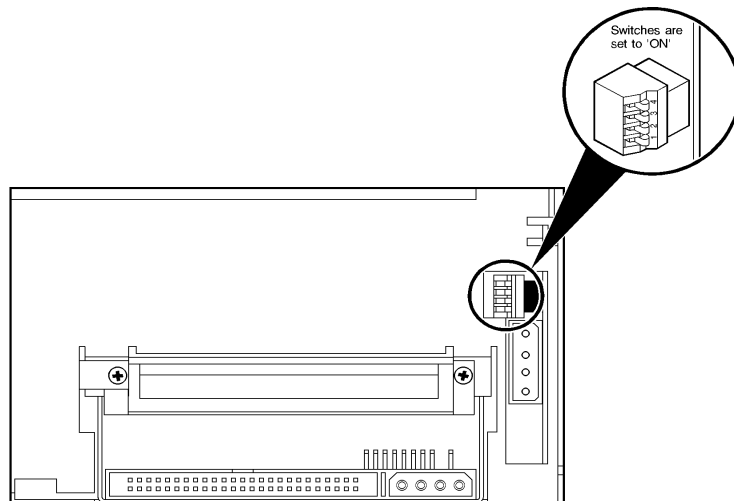
When the autoloader is switched off, you can set the following configurations (other settings are not used at this time). For more precise details, and settings recommended for different systems, see the *HP DDS Configuration Guide*, Volume 5 of the HP DDS Technical Manual.

Note LUN 0 is the drive mechanism, LUN 1 is the changer mechanism.

| Switches				Value	Auto-stack	Auto-eject	Allow Resequencing	LUN 1 Magazine Ready	LUN 0 Drive Inquiry
4	3	2	1						
off	off	off	on	1h	Enabled	Enabled			
off	on	on	off	6h *(HP Series 800)*			Enabled	Enabled	Enabled
off	on	on	on	7h *(HP Series 700)*			Enabled	Enabled	
on	on	on	on	Fh *(Default)*					

Auto-stack — The autoloader enters Stacker mode (see "Modes of Operation" on page 4-2) after a magazine has been inserted.The first cartridge is loaded automatically.

Auto-eject — When the autoloader is in Stacker mode it will eject the magazine after the last cartridge in the magazine is unloaded.

Allow Resequencing — While the autoloader is in Stacker mode, you can select another cartridge to be loaded into the drive by using the Select and Load buttons. When this option is *not* enabled, the Load and Select buttons are ignored in Stacker mode.

LUN 1 Magazine Ready — A TEST UNIT READY command to LUN 1 will receive a NOT READY status message unless a magazine in present and magazine census data is available. When this option is *not* enabled, a TEST UNIT READY command will receive a GOOD status report whenever the autoloader has completed the power-on self-tests. This provides a method of detecting whether a magazine is present.

LUN 0 Drive Inquiry — The product ID sent in response to an INQUIRY command to LUN 1 will be that of the embedded tape drive.
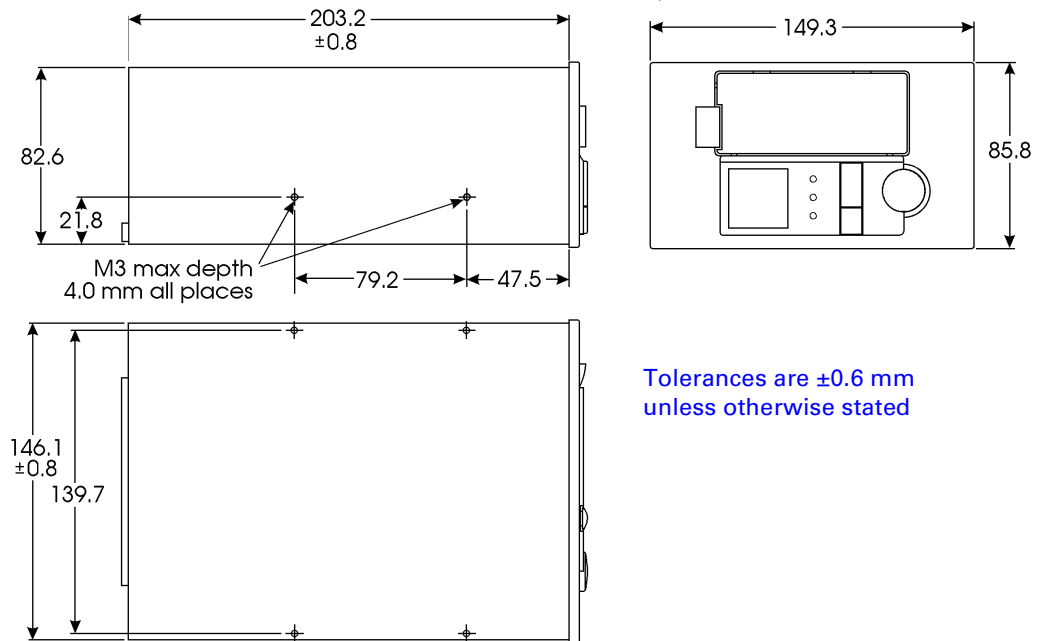When this option is *not* enabled the ID sent is that of the entire autoloader.

Fixing Requirements

The position of fixing points is shown in figure 2.11 for drives and figure 2.12 for autoloaders.

Note Screw threads must not penetrate more than 4 mm into the drive.

Figure 2.11 Drive fixing points
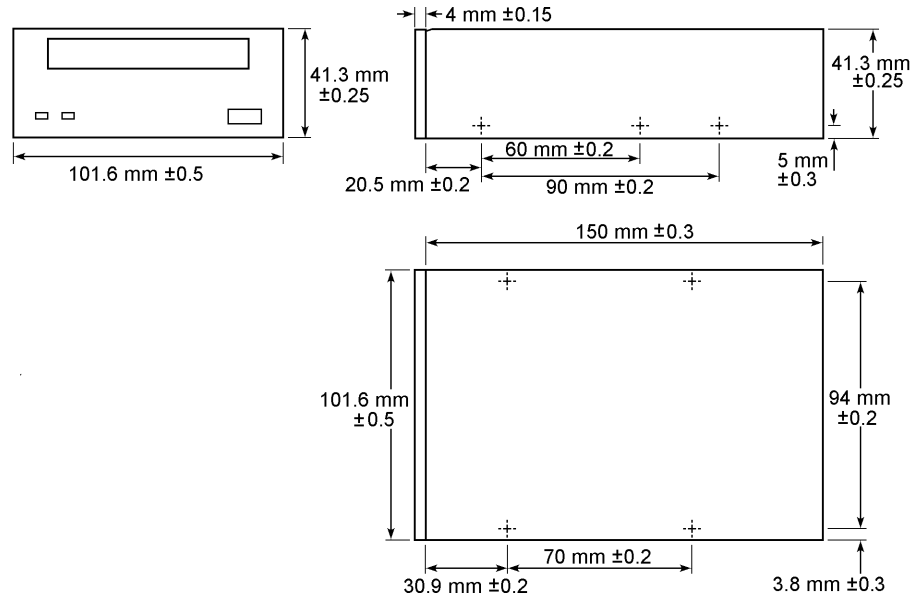
Figure 2.12 Autoloader fixing points

Tolerances are ±0.6 mm
unless otherwise stated

Airflow and Cooling Requirements

In order to keep temperature and humidity at acceptable levels, you are advised to ensure that forced airflow is provided across the drive or autoloader.

Depending on the type of installation, the airflow may be as low as 0.03 m³/min (1 ft³/min) through the drive, or 0.3 mm (0.01 in) of water pressure drop. This level of airflow may be achieved by the use of a very small fan, say 40 mm (1½ in) square. As a guideline, a typical 80mm (3 in) square fan in a system box produces 0.6 to 0.9 m³/min (20 to 30 ft³/min).

Note Make sure you do not have any unfilled peripheral slots in your system. These may cause airflow to bypass the drive completely.

Monitoring Airflow

Note The relationship between airflow and pressure drop depends heavily on the actual design of the cabinet in which the drive is placed. The important factor is to ensure that the drive is within the specified temperature limits.

An appropriate method to establish whether you have adequate airflow over the drive is to measure temperatures at two key sites. Each product must meet two conditions:

Location	Max Temp Difference*
The temperature of the biggest integrated circuit in the center of the PCB: HP 35470A U5 HP C1534A U4 HP C1557A U7 HP 35480A U5 HP C1536A U4 HP C5683A U6 HP C1533A U13 HP C1539A U6 HP C5713A U6 HP C1553A U13 HP C1537A U7	39°C
The temperature of the head/tape interface on the left-hand side, looking from the front	12°C

* The maximum difference between the applied temperature and the measured temperature. For example if the applied temperature is 25°C (in other words, ambient) and the measured temperature is 40°C, the maximum difference will be 40°–25° = 15°C.

The same applies to the head/tape interface. For example if the applied temperature is 25°C, you should provide sufficient air flow so that the temperature of the head/tape interface does not exceed 37°C (37–25 = 12).

The test conditions should be as follows:

1 Power up the drive with a tape loaded but not performing any commands.

2 Allow a minimum of two hours for the temperature to stabilize.

Testing should be completed for the worst-case physical configuration for airflow.

Alternative Method

A simpler but less accurate method is to monitor a single point on the "underside" of the drive. Fix a thermocouple at the point and make sure that the measured temperature does not exceed 52°C:

This point should be limited to a maximum of 12°C above the applied temperature. For example, if the applied temperature is 40°C (surrounding), then you need to ensure that there is sufficien air flow so that this point does not exceed 52°C (40+12).

| Drive	Location on the underside	
	From the front	*From the side*
HP 35470A HP 35480A	100 mm	50 mm
HP C1533A HP C1553A	70 mm	50 mm
HP C1534A HP C1536A	70 mm	40 mm from the left side looking from the front
HP C1539A HP C1537A HP C1557A	50 mm	50 mm
HP C5683A HP C5713A	55 mm	35 mm from the right side looking from the front

3

Operation—Drives

Front Panel

Figure 3.1 Front panel

Activity light —
Attention light —
— Unload button
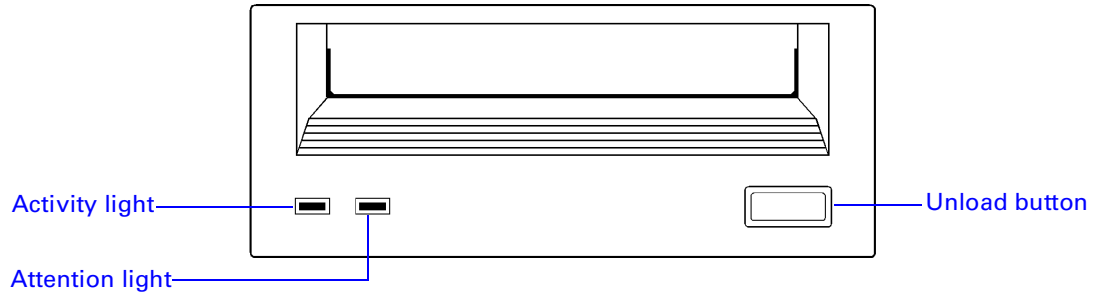
The lights on the front panel operate as follows:

Activity Light
- *Flashing green* shows activity (loading, unloading, reading, or writing).
- *Steady green* means a cartridge is loaded.

Attention Light
- *Flashing amber* indicates that a cartridge is near the end of its life or that the heads need cleaning (the Media Caution signal—see below).
- *Steady amber* indicates a hard fault.

Figure 3.2 illustrates the meaning of different patterns of lights:

Figure 3.2 Front panel lights

Activity	Attention	Meaning
Flash Green	Off	Activity—load or unload
Fast Flash Green	Off	Activity—read or write
Green	Off	Cartridge loaded
any	Flash Amber	Media Caution signal
any	Amber	Fault
Flash Green	Off	Power-on (starts with two steady lights)

Key

Off	Off
Green	Green
Amber	Amber
Flash Green	Flash Green (½s on, ½s off)
Flash Amber	Flash Amber (½s on, ½s off)
Fast Flash Green	Fast Flash Green (¼s on, ¼s off)

Media Caution Signal

HP drives monitor the number of correctable errors that occur during reading and writing. If the number or errors grows excessive, it can mean that the tape is nearing the end of its useful life, or that the tape heads need cleaning.

If the Media Caution signal appears, clean the tape heads as described on page 3-5.

If the signal is still displayed after cleaning the heads, repeat the operation with a different tape. If this clears the signal, the first tape is nearing the end of its life. Copy the data onto a new tape and discard the old one.

The Media Caution signal is cleared when a new tape is loaded or when the drive is power-cycled.

Loading and Unloading

Caution Stick cartridge labels firmly to the recessed label area. To avoid a mechanism jam, observe the following recommendations:
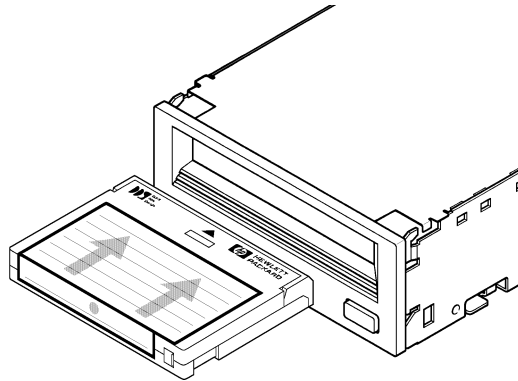
- Labels must not be peeling off
- Stick labels only within the label area
- Do not stick a label on top of another label

Only use cartridges labelled with a DDS logo in the drive—never use DAT cartridges (see Chapter 4).

Inserting Cartridges

Figure 3.3 Inserting a cartridge

Insert a cartridge into the slot on the front panel. As the cartridge is inserted, the drive takes it and performs a load sequence.

Note By default, the drive is configured to detect DDS Media Recognition System cartridges. If you load a cartridge which is not DDS Media Recognition System, the cartridge will be treated as write-protected; you will only be able to read it, not write to it. See Chapter 4 for more details.

The load sequence is as follows:

1 The drive mechanism threads the tape and rewinds to BOM (Beginning of Media). The drive then reads the first Reference area on the tape (Partition 1 on a 2-partition tape) to find the tape format (DDS, audio, and so on) and the number of partitions.

2 If the tape is blank, the drive leaves the tape at BOP (Beginning of Partition) for Partition 0 and awaits the next command.

3 If the error rate is high, the Media Caution signal is set on the front panel lights (the Attention light flashes amber).

4 The System area on the tape is then accessed and the Tape log read into the drive. (Note that the Tape log is not loaded for HP C1534A/36A drives with firmware version T503.)

5 Finally the drive rewinds to BOP (Partition 0).

Removing Cartridges

A cartridge can be removed either in response to a SCSI LOAD/UNLOAD command or if you press the Unload button.

For either of these methods the drive performs an Unload sequence:

1 The tape is rewound to BOP for Partition 0.

2 If the tape is write-enabled, the copy of the Tape log is written back to tape. (This does not occur for HP C1534A/36A drives with firmware version T503.)

3 The tape is then rewound to BOM, unthreaded from the mechanism, and ejected.

Note If the host has previously sent a PREVENT MEDIA REMOVAL command, operation of the Unload button is disabled; pressing the button has no effect, and does not initiate an Unload sequence. The Unload button returns to normal operation when the drive receives an ENABLE MEDIA REMOVAL command or a SCSI reset.

Forcing the Ejection of a Cartridge

Caution Only force ejection as a last resort to recover a cartridge. Never use it as a quick way of ejecting the cartridge. You may lose data if you force ejection. The tape can also end up invalidly formatted, because EOD may not have been written.

If you press the Unload button when the drive is busy, it may be a long time before the drive will respond to the request, because it must first finish the task on which it is engaged. This ensures that the task is terminated in a controlled manner and no data is lost.

However, there may be occasions when you need to unload a cartridge urgently, even at the risk of losing data. To do this, you must *force ejection*. There are two ways of doing this:

■ Press the Unload button three times within a 5-minute period (or press the Unload button twice in the 5 minutes following a SCSI UNLOAD command).

■ Hold the Unload button down for at least 5 seconds.

Following either of these actions, the drive first waits for 35 seconds from the time of the first press, in order to give the normal eject procedure a chance to be followed. Once this period of grace has elapsed, it immediately unthreads the tape and ejects the cartridge, regardless of what operation it was performing. The drive is then reset as though the power had been switched off and then on again.

Because forced ejection may interrupt any operation, it is possible that the drive will not write EOD before the cartridge is ejected. This will cause loss of data, and result in a cartridge with an invalid format.

Note A forced ejection overrides any SCSI PREVENT MEDIA REMOVAL which may be in effect, and can abort any SCSI operations which may be in progress on the drive.

Taking Care of the Drive

DDS drives require little care and maintenance. The two main activities are to clean the heads regularly, and to avoid condensation and temperature extremes.

Head Cleaning

Clean the tape heads regularly using the guidelines in the following tables. Tape heads should also be cleaned if the Media Caution signal is displayed on the front panel (the Attention light flashes amber) and continues to be displayed when you repeat the operation with a new tape.

HP C1534A, HP C1536A, HP C1533A

Number of DDS cartridges used each day	≤1	2–3	4+
Cleaning Interval	Weekly	Twice a week	Daily

HP C1537A, HP C1539A, HP C5683A

Number of DDS cartridges used each day	≤1	2	3	4+
Cleaning Interval	8 weeks	4 weeks	3 weeks	Weekly

Clean the heads using a cleaning cartridge, HP 92283K, as follows:

1 Insert the cleaning cartridge into the drive. The drive automatically takes the cartridge, loads it, and cleans the heads.

2 After about 30 seconds (20s for the HP C1537A), the drive ejects the cartridge.

3 Take the cleaning cartridge out of the drive, and write the date on the label on the cartridge. This provides a record of how many times the cartridge has been used. You need to know this, because a cleaning cartridge has a life of typically 50 cleaning cycles.

Note Cleaning cartridges can only be used about 50 times. For the HP C1537A, HP C1539A and HP C5683A, software applications can warn you when the cleaning cartridge has reached the end of its life and needs replacing by polling the drive's TapeAlert log. For other drives, the cartridge will be ejected after only about 14 seconds when the cleaning cartridge has expired. (In the case of the HP C1533A, the Media Caution signal may still be displayed.) If any of these events occurs, discard the cleaning cartridge and repeat the cleaning operation with a new one.

Prolonging Head Life

Drives are optimized to achieve the best performance possible and a typical head life in excess of 6000 hours. This figure assumes that you use the appropriate tape for the drive (such as DDS-4 media with DDS-4 drives), and that you follow a typical usage pattern.

You may not attain the typical head life when:

■ You use an older tape format, such as DDS-2 tapes with a DDS-3 drive.

■ A large proportion of cartridges loaded are being used for the first time.

Temperature and Condensation

Condensation is bad for tape drives. To minimize the chance of condensation, keep within the environmental limits given in the specifications (see page 8-3).

To avoid temperature problems, observe these guidelines:

❏ Position the drive in a position where the temperature is relatively stable, for example, away from open windows, fan heaters and doors.
❏ Do not leave cartridges in severe temperature conditions, for example in a car standing in bright sunlight.
❏ Do not transfer data (reading from and writing to cartridges) when the temperature is changing by more than 10°C (18°F) per hour.
❏ After either the drive or the cartridge have been subjected to extreme temperature changes (>15°C, 27°F), do not use the drive for at least two hours to allow the temperature of the drive and cartridge to stabilize.

Removing Power from the Drive

To ensure reliable operation, do not remove power from the drive during read, write, fast-search, load and unload activities.

Upgrading Firmware from Tape

HP DDS drives allow you to upgrade firmware by inserting a Firmware Upgrade cartridge.

Caution Do not disconnect power during the upgrade, particularly when the front panel lights are flashing, or it may result in the drive having corrupt firmware or no firmware at all. The drive will then have to be returned to the factory.

To upgrade firmware:

Note ■ If the firmware upgrade is incompatible with your hardware, no upgrade will take place. The tape will be ejected after about 1 minute instead of the usual 3 minutes.
■ The upgrade tape must not be write-protected.
■ The upgrade tape can only be used a certain number of times. After that, a drive will reformat it for normal data use, although given the amount of use it will have had, it is not advisable to use it for data.
■ You cannot convert a firmware upgrade tape for normal data use.

1 Ensure that the drive is not engaged in any SCSI activity (the Activity light is off and the host is not going to be accessing the drive).

2 Insert the Firmware Upgrade cartridge into the drive.

3 The upgrade process automatically takes place. During the actual erasure and reprogramming of the firmware, *it is critically important that you do not power down the drive.* The front panel lights flash rapidly during this critical time.

4 After about three minutes, when the upgrade is complete, the cartridge will be ejected. Remove it, and replace it in its box.

Upgrade Tapes for Multiple Drives

From late 1995, drives began to be able to support tapes that contain upgrades for more than one drive. When the upgrade tape is inserted, the drive reads successive upgrades from the tape until it reaches one which matches its hardware. It will then upgrade the firmware. The whole process will take about 15 seconds longer for each upgrade version which needs to be skipped.

If you insert a tape with multiple upgrade versions into a drive which does not support tapes of this kind, the drive will only look at the first upgrade version on the tape. If this matches its hardware, the drive will update the firmware. If it does not match, the tape will be rejected.

4

This chapter gives details of the basic operation of the autoloaders (HP C1553A, HP C1557A and HP C5713A), and the meaning of the front panel displays.

No maintenance is necessary apart from regular cleaning of the tape heads. See the section "Head Cleaning" on page 4-9.

Operation—Autoloaders

Modes of Operation

The autoloaders may be operated in either Stacker or Random mode.

In *Stacker* mode (also known as Sequential mode), you can select which cartridge you want by using the Select and Load buttons on the front panel. When a cartridge is ejected from the embedded drive after a host UNLOAD command, the autoloader automatically moves the next available cartridge from the magazine into the drive. The autoloader does not depend on the host computer sending SCSI Medium Changer commands to move cartridges to and from the magazine.

In *Random* (or Changer) mode, the host views the autoloader as two devices:
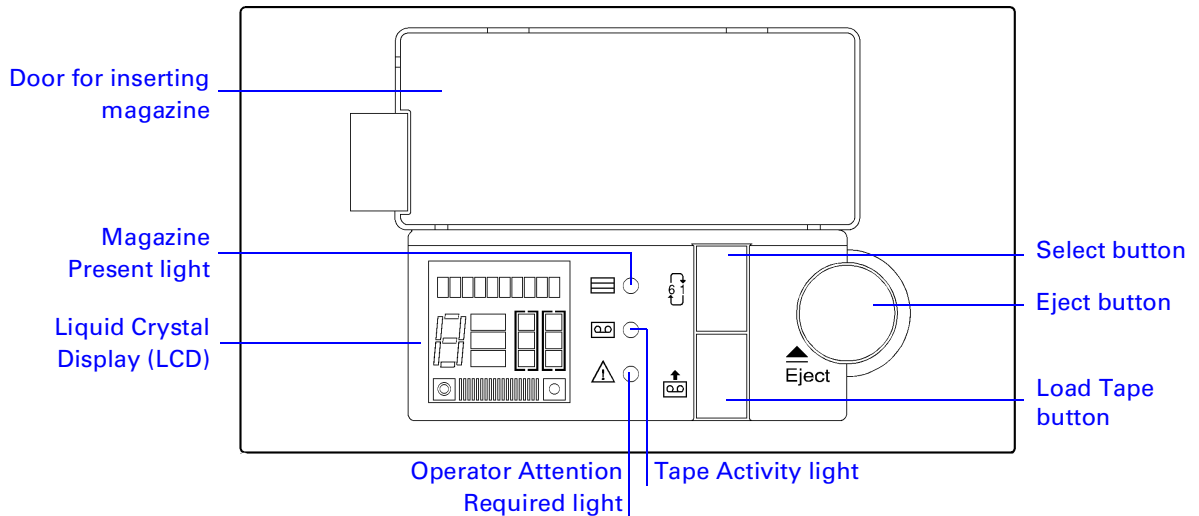
■ A tape drive to which SCSI Sequential Access commands can be sent.

■ A changer mechanism to which SCSI Medium Changer commands can be sent.

The controlling host computer therefore has full random access to any cartridge.

Front Panel

Figure 4.1 Autoloader front panel

The autoloader front panel consists of the following:

■ A door through which the magazine is loaded
■ The Select button
■ The Eject button
■ The Load Tape button
■ A liquid crystal display (LCD)
■ Three lights (LEDs)—the Magazine Present light, the Operator Attention light, and the Tape Activity light

Front Panel Buttons

Select Button

The Select button allows you to select any of the cartridges in the magazine after the magazine has been autoloaded into the unit. If you press the Select button repeatedly, the display cycles through the cartridges available in the magazine. You then press the Load Tape button to load the selected cartridge.

In Random mode, the Select button is disabled.

Load Tape Button

Use the Load Tape button to load the selected cartridge from the magazine into the drive. This puts the drive into Stacker mode; when the selected cartridge is ejected following a host UNLOAD command, the drive will automatically load the next highest numbered cartridge.

In Random mode, the Load Tape button is disabled.

Eject Button

The Eject Button starts the unload process. The drive unloads any currently loaded cartridge, and the changer mechanism returns the cartridge to the magazine. The magazine is then ejected. The button can also be used to force ejection in an emergency. See "Forcing Ejection" on page 4-9.

Note The host computer can disable the Eject Button by sending a SCSI PREVENT MEDIA REMOVAL command.

Front Panel Liquid Crystal Display (LCD)

The five display regions of the LCD provides information about the autoloader. Note that the exact display shown in figure 4.2 can never occur; all the sections are showing at the same time so that you can see where they are.

Figure 4.2 Front panel LCD
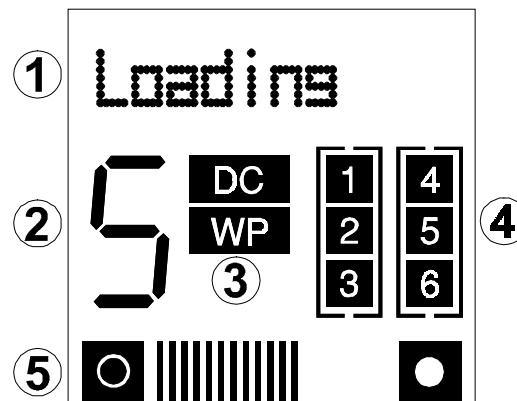
1 The 10-character dot matrix display provides information on the autoloader's operating status and potential error conditions. See "LCD Messages Categories" on page 4-4 for details of the kinds of messages that can be displayed here.

2 The 7-segment display shows the number of the current cartridge loaded in the drive, or the cartridge selected when you press the Select button repeatedly.

3 "**DC**" (Data Compression) and "**WP**" (Write-Protected) in the center of the LCD indicate when data compression is being used for writing, and whether the cartridge is write-protected.

4 The six numbered boxes on the right of the LCD are individually lit to show which magazine slots contain a cartridge.

5 The display at the bottom of the LCD shows how much tape has been used in the current partition. The more lines shown, the more tape has been used. When all the lines show, the partition is full.

Front Panel Lights

The autoloader has three front panel lights (see <u>figure 4.1</u>):

Magazine Present (top light)—green

Steady green   A magazine is installed.

Flashing green   A magazine is being installed, checked or ejected. The light also flashes during the autoloader's self-test routine.

Tape Activity (middle light)—green

Steady green   A cartridge is present in the drive.

Flashing green   4 Hz   Data is being read or written, or activity other than the cartridge being loaded or unloaded is occurring.

   2 Hz   A cartridge is being loaded or unloaded. The light also flashes during the autoloader's self-test routine.

Operator Attention Required (lower light)—amber

Steady amber   A serious hardware error has occurred.

Flashing amber   A user-recoverable error has occurred. The exact meaning depends on the rate of flashing:

   4 Hz   A firmware upgrade is taking place.
   2 Hz   The tape is nearing the end of its useful life.
   2 Hz   The heads need cleaning.
   1 Hz   A hard fault condition has occurred that the drive cannot easily clear.
   1 Hz   There is a tape in the autoloader but no magazine.
   1 Hz   The front panel door is open when it should not be.

To find which of these applies, read the message on the top line of the LCD and then refer to <u>"LCD Messages" on page 4-11</u>. Take corrective action if possible. If necessary, call for Service.
The light also flashes at 2 Hz during the autoloader's self-test routine.

LCD Messages Categories

The type of information displayed by the LCD can be divided into three categories:

■ Normal autoloader operating status information
■ Error messages

■ Information messages

These types are described below. All the messages are listed on page 4-11 in alphabetical order. The type of message is indicated by the letter **S** (Status), **E** (Error) or **I** (Informational).

Status Messages

The status messages that appear on the LCD cover five functional states or areas of activity of the autoloader. When switched on, the autoloader moves through the states in the following order:

Reset   At power on, the autoloader is in Reset state until the self-test has been passed.

Firmware Upgrade   If a firmware upgrade tape is in the drive or an upgrade is taking place over the SCSI bus from the host, the autoloader moves into the Firmware Upgrade state after passing the self-test.

Magazine Load   If no upgrade is being performed, the autoloader moves into the Magazine Load state, and remains there until a magazine has been loaded.

Cartridge Load   After a magazine has been loaded, the autoloader moves into the Cartridge Load state until a cartridge has been moved to the drive and loaded.

Tape Motion   Once a tape has been loaded, the Tape Motion state covers activity involving the tape, including reading and writing data.

The table below shows the messages that can be displayed in each functional state. The messages in brackets are not displayed on the LCD, because the autoloader will have already have moved to the next functional state.

State:	**Reset**	**Firmware Upgrade**	**Magazine Load**	**Cartridge Load**	**Tape Motion**
Messages:	`Self Test`				
	`(Test OK)→`	`FW Upgrade`			
		`FW Check`			
		`FW Program`			
		`New FW!!!!`			
		`(No Upgrade)→`	`Insert Mag`		
			`Mag Check`		
			`Mag Eject`		
			`(Mag Loaded)→`	`Mag Loaded`	
				`SemiLoaded`	
				`Loading`	
				`Unloading`	
				`Cleaning`	
				`FW Tape`	
				`(Tape Loaded)→`	`Ready xxm`
					`Read`
					`Write x.y`
					`Search >>`
					`Search <<`
					`Rewind`
					`Format`
					`Erase`
					`Locate`
					`Partition`

Error Messages

The LCD can display a range of error messages relating to the autoloader's operation. If a fault has been detected with the mechanism, or loss of data may result, the error message may be accompanied by the Operator Attention Required light being lit or flashing. This is indicated in the OAR column in the alphabetical list of messages on page 4-11.

Where possible, actions that you can take to recover from the error are also given.

For further information on errors, see Chapter 6, "Troubleshooting."

Information Messages

Informational messages are displayed when power is applied to the autoloader. They indicate its identity, SCSI ID and configuration. They also tell you when you have pressed the front panel buttons to confirm that the autoloader has recognized the action.

Loading the Magazine and Cartridges

Caution *Use the correct cartridges:*
- Only use cartridges labeled "DDS Media Recognition System" in the drive. To exploit the full potential of the drive, make sure that they are DDS-2 cartridges for the HP C1553A, DDS-3 cartridges for the HP C1557A or DDS-4 cartridges for the HP 5713A.
- *Never* use DAT cartridges, because the media is not certified, and they can have a different specification that can cause them to jam in the mechanism.
- Do not use DDS-3 or DDS-4 cartridges with the HP C1553A, or DDS-4 cartridges with the HP 1557A; the drives will simply eject them.

To avoid jams, insert cartridges in the magazine in their proper orientation and fully pushed home.

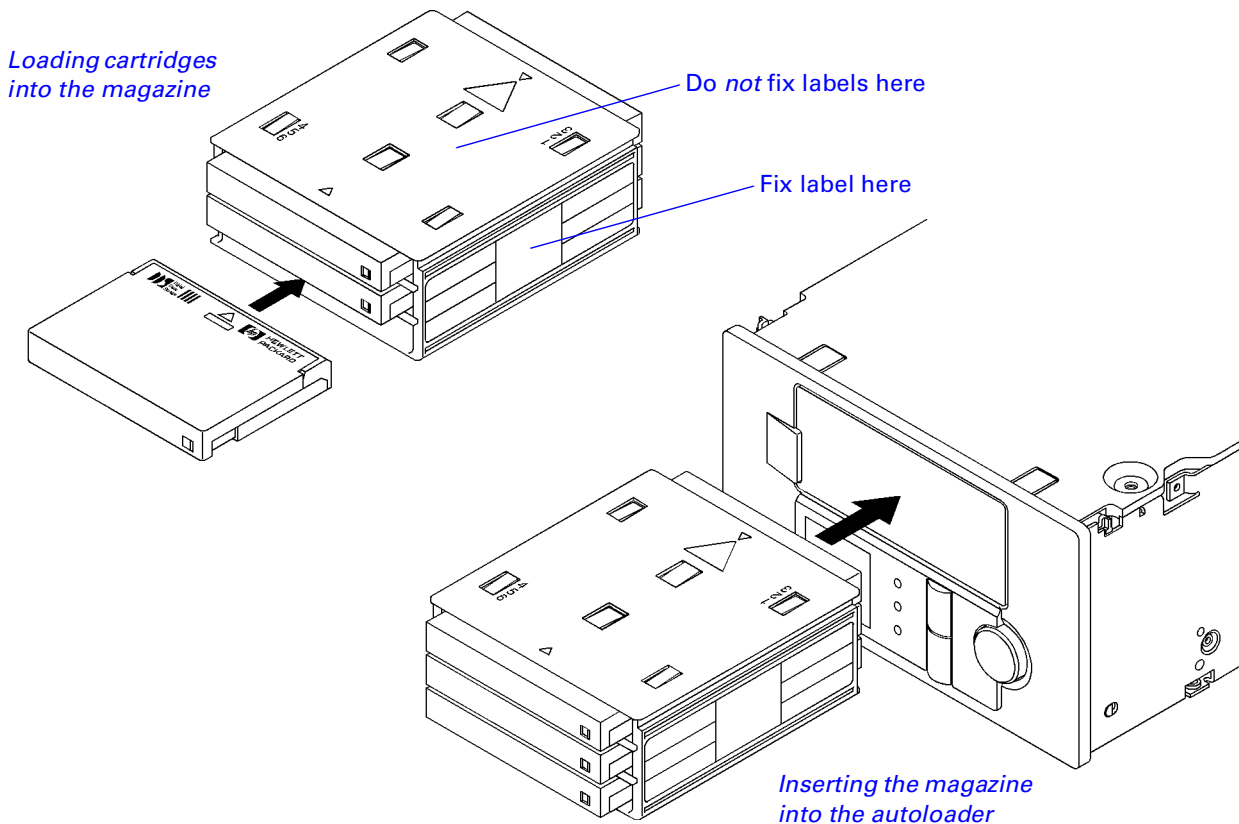*To avoid mechanism jams, use labels properly:*
- Only stick labels in the label areas on cartridges and magazines (see figure 4.3).
- Ensure that the corners of cartridge and magazine labels stick firmly to the surface and do not curl at their edges.
- Never stick labels on top of other labels.

Note It is recommended that you store cartridges in their magazines, so that cartridges belonging to a multi-volume backup are kept together and in the correct order.

Figure 4.3 Loading the magazine and cartridges

Loading cartridges into the magazine

Do *not* fix labels here

Fix label here

Inserting the magazine into the autoloader

1 Place as many cartridges as you need into the magazine, pointing towards the center of the magazine (see figure 4.3). Make sure that the small arrows on the magazine and cartridge line up.

You can use any number of cartridges from 1 to 6, and place them in any of the magazine slots. However, for ease and speed of use, start by using slot 1. During a sequential backup, by default the drive will attempt to load the first cartridge from slot 1.

2 To install the magazine, insert it into the slot in the front of the autoloader with the large arrow uppermost and pointing towards the autoloader (see figure 4.3). Apply steady pressure until the mechanism takes the magazine and pulls it into the autoloader.

3 The autoloader then performs a self-test routine. This also checks which magazine slots contain cartridges.

4 When the self-test and magazine check is complete, if you are using the autoloader in Stacker mode, select the cartridge with which you want the sequence to start by pressing the Select button. When the correct number is displayed, press the Load Tape button to load the cartridge.

In Random mode, the host computer selects and moves a cartridge from the magazine into the drive mechanism.

Note The drive is configured to use DDS Media Recognition System cartridges. Any cartridge that is not DDS Media Recognition System will be treated as write-protected—you will only be able to read it, not write to it.

5   The drive now performs a load sequence. This takes a maximum of 25 seconds from the time the cartridge is inserted to the time the drive is ready to start acting upon the next command from the host. The sequence is as follows:

   a   The drive mechanism threads the tape and rewinds it to Beginning of Media (BOM). It checks the tape format (such as DDS-2 or audio) and the number of partitions. If the tape is blank, the drive leaves the tape at Beginning of Media (BOM) and awaits the next command.

   b   If the tape is in DDS format and is write-enabled, the drive performs write and read tests. If the error rate is high, the Operator Attention Required light flashes and "`Clean Me`" is displayed on the LCD.

   c   The drive copies the Tape log from the tape into RAM.

   d   The drive rewinds to BOP (Beginning of Partition) and goes online, awaiting a command from the host.

6   Once the drive is online, it sends a CHECK CONDITION on receipt of the next SCSI command from the host. The UNIT ATTENTION key is set in the returned REQUEST SENSE data to indicate that the tape may have been changed.

Ejecting the Magazine and Cartridges

To eject a cartridge from the autoloader, press the Eject button. The following sequence of events occurs:

1   The tape is rewound to BOP (Beginning of Partition).

2   If the tape is write-enabled, the copy of the Tape log held in RAM is written back to tape.

3   The tape is then rewound to BOM (Beginning of Media) and unthreaded.

4   The changer mechanism replaces the cartridge in the magazine.

5   The magazine is ejected.

If the host sends an Unload command (LOAD/UNLOAD with the LOAD bit set to 0), the same procedure is followed but the magazine is not ejected at the end.

If you press the Eject button during the 30 seconds when the autoloader checks magazine slots following insertion of a magazine, the magazine will be ejected immediately, even if Medium Removal Prevention is in force.

Note   If the host has previously sent a PREVENT MEDIA REMOVAL command, the unloading action is different in two ways:

■   The Eject button is disabled and has no effect. It does not initiate an unload sequence.

■   An Unload command puts the drive into the semi-loaded state. That is, it takes the drive offline and unthreads the tape, but does not eject it.

The effects of PREVENT MEDIA REMOVAL continue until an ENABLE MEDIA REMOVAL command is received, or the drive is reset.

Forcing Ejection

Caution You can lose data if you force ejection of a tape. The tape may also end up invalidly formatted, because EOD (End of Data) may not have been written. Only force ejection as a last resort to recover a cartridge. *Never use it as a quick way of ejecting the cartridge.*

If you press the Eject button when the drive is busy, it may be a long time before the drive will respond to the request, because it will finish the task it is performing first. This ensures that the task is terminated in a controlled manner, and no data is lost.

However, if you need to unload a cartridge urgently, even at the risk of losing data, you must force ejection as follows:

1 Hold the Eject button down for at least 5 seconds until the LCD displays "`Force Eject`".

2 The autoloader waits 35 seconds to give the normal ejection procedure a chance.

3 Once this time has elapsed, if there is a tape loaded in the drive, it is immediately unthreaded and the cartridge is ejected, regardless of what operation the drive was performing. The cartridge is then returned to its slot in the magazine, and the drive is reset as though the power had been cycled.

Because the forced ejection may interrupt any operation, it is possible that the drive will not write EOD (End of Data) before the cartridge is ejected. This will cause loss of data, and result in a cartridge with an invalid format. However, it should still be possible to read such a cartridge up to the point where the ejection interrupted the writing.

4 If no cartridge is loaded in the drive, the autoloader assumes that you want to eject the magazine. Following the 35 seconds, it does this. The autoloader is then reset as though power had been cycled.

Note Forced ejection overrides any SCSI PREVENT MEDIA REMOVAL that may be in effect, and can abort any SCSI operations in which the autoloader is engaged.

Head Cleaning

Clean the tape heads at the following times:

- After every 25 hours of use
- When a "`Clean Me`" message is displayed in the front panel LCD and the Operator Attention Required light is flashing amber.

As a rough guideline, the frequency of cleaning is likely to be as follows:

HP C1553A

Number of cartridges used each day:	≤**1**	**2–3**	≥**4**
Cleaning frequency:	Weekly	Twice a week	Daily

HP C1557A and HP C5713A

Number of cartridges used each day:	≤**1**	**2**	**3**	≥**4**
Cleaning frequency:	8 weeks	4 weeks	3 weeks	Weekly

Clean the heads using a cleaning cartridge, HP 92283K, as follows.

Note Cleaning cartridges can only be used about 50 times.

With the HP C1557A, software applications can warn you that a cleaning cartridge has expired by polling the TapeAlert log.

With both autoloaders, an expired cleaning cartridge will be ejected in less than 20 seconds instead of the usual 30 seconds. With the HP C1553A, if the "`Clean Me`" message was showing before the attempt to clean the heads, it will still be showing afterwards.

Cleaning the Heads in Stacker Mode

1 Place the cleaning cartridge into one of the magazine slots (for example, slot 1) and insert the magazine into the autoloader.

2 Use the Select button to select the magazine slot in which you placed the cleaning cartridge.

3 Press the Load Tape button to load the cleaning cartridge into the drive. The autoloader will then automatically perform a cleaning cycle.

4 At the end of the cleaning cycle, the drive automatically ejects the cartridge and the changer mechanism replaces it in the magazine.

5 Note the date on the label on the cleaning cartridge, so that there is a record of how many times it has been used. After 50 uses, discard the cartridge.

Note If you decide to leave a cleaning cartridge permanently in the magazine, it will reduce the amount of data you can back up to the magazine, since you will only have five slots available for data cartridges.

Cleaning the Heads in Random Mode

1 The host sends a MOVE MEDIUM command to move the cleaning cartridge from the magazine to the drive. The autoloader will only recognize that the cartridge is a cleaning cartridge once it is loaded into the drive.

2 The drive will then automatically carry out a cleaning cycle.

3 The drive automatically ejects the cartridge after the cleaning cycle is complete. The changer returns the cartridge to its magazine slot without further host involvement.

In Random mode, the host can program a routine cleaning cycle (say, once a week). The cleaning cartridge remains in a set position, such as, slot 6, ready for use at the designated time. Remember that this will reduce the amount of data you can back up to the magazine, since you will only have five slots available for data cartridges.

Note Using the SCSI MOVE MEDIUM command, a cleaning cartridge can only be returned to its original source slot in the magazine.

Prolonging Head Life

Drives are optimized to achieve the best performance possible and a typical head life in excess of 6000 hours. This figure assumes that you use the appropriate tape

for the drive (such as DDS-4 media with DDS-4 drives), and that you follow a typical usage pattern.

You may not attain the typical head life when:

■ You use an older tape format, such as DDS-2 tapes with a DDS-3 drive.

■ A large proportion of cartridges loaded are being used for the first time.

Avoiding Condensation

Condensation is bad for tape drives, where a thin tape is passing across a rapidly spinning head. To minimize the risk of condensation, keep to the environmental requirements on page 8-3.

To avoid temperature problems, follow these guidelines:

■ Position the autoloader in a position where the temperature is relatively stable, for example, away from open windows, fan heaters and doors.

■ Avoid leaving cartridges in severe temperature conditions, for example in a car standing in bright sunlight.

■ Avoid transferring data (reading from and writing to cartridges) when the temperature is changing by more than 10°C (50°F) per hour.

■ After either cartridge or autoloader has experienced an extreme change of temperature (more than 15°C, 59°F), do not use the autoloader for at least two hours to allow the temperature of the autoloader and cartridges to stabilize.

LCD Messages

The following list gives the messages that can be shown on the front panel LCD in alphabetical order. See also "LCD Messages Categories" on page 4-4.

The **Type** column can show three letters:

E   Error messages
I   Informational messages
S   Status messages

The **OAR** column indicates the state of the Operator Attention Required light on the front panel while the message is being displayed:

O   On
F   Flashing

Note The HP C5713A also displays the URL of the HP World Wide Web Support page with certain messages.

Number Codes (HP5713A only)

The HP C5713A autoloader has a language selection feature, which allows you to localize the display for French, German, Spanish, Portuguese or Japanese. If your language is not supported, you can select a Numerical code instead and refer to the list of messages below for an explanation of the code.

#	LCD Message	Type	OAR	Meaning
1019	At BOD	E	O	A SPACE command encountered BOD unexpectedly. The tape is now positioned at BOD.
1018	At EOD	E	O	A READ or SPACE command encountered the EOD area unexpectedly. The tape is now positioned at EOD.
8014	Bad Media	E	F	A READ or SPACE command has failed because the tape is not in DDS format. *Action:* Unload the tape and use a DDS-certified (Media Recognition System) tape.
8021	Cannot Write Non-MRS Tape	E	F	A WRITE, WRITE FILEMARK or ERASE command has been attempted on non-Media Recognition System tape. *Action:* Remove the cartridge and replace with a Media Recognition System cartridge.
8009	Clean fail: Check Cleaning Tape	E	F	Cleaning failed, possibly due to an expired tape. *Action:* Use a new cleaning cartridge.
2001	Clean Me	E	F	A high error rate has been detected reading or writing. *Action:* Insert a cleaning cartridge to clean the tape heads, ensuring that the tape in the cleaning cartridge has not been used up. See "Head Cleaning" on page 4-9.
1008	Cleaning	S		A cleaning cartridge has been loaded into the drive mechanism.
2006	Close Door	E	F	The front panel door is open. Any autoloader motion will be delayed. *Action:* This is probably caused by a magazine that is partly inserted through the door. Push the magazine fully home or remove it.
8002	Drive Comms Error	E	O	The drive has stopped communicating with the changer mechanism. *Action:* Call for service.
8001	Drive fault	E		The drive has detected an internal error.
8004	Eject Fail	E	F	An eject command has failed, either after you pressed the Eject button or after a host command. *Action:* Try forcing ejection (see page 4-9).
2010	Eject Mag	I		This is displayed when you press the Eject button.
1015	Erase	S		The drive is erasing data from the tape.
8000	Error *X*	E	F	The mechanism has jammed. The number *x* gives the reason for the jam. *Action:* Press the Eject button to attempt to recover the cartridge and magazine. If the problem persists, note the value of *x* and call for service.
4003	ERROR: No tape in slot 1	I		HP OBDR requires a cartridge in slot 1 from which it can boot.
4001	ERROR: Unable to boot from tape	I		The system cannot boot from the loaded tape.
1023	ForceEject	I		A forced ejection is in progress (see page 4-9).
1014	Format	S		A SCSI command for generating a one- or two-partition tape is being executed, or the drive is changing the size of the partitions on an existing two-partition tape.
3002	FW Check	S		Firmware upgrade data is being checked for compatibility.
8024	FW Data Err	E	F	The autoloader has failed to upgrade the drive firmware, because the new firmware is corrupt. *Action:* Obtain a good copy of the firmware upgrade.

#	LCD Message	Type	OAR	Meaning
3003	**FW Program**	**S**		The drive is being upgraded with the new firmware.
3005	**FW Tape**	**S**		The cartridge loaded in the drive mechanism is a firmware upgrade tape cartridge.
3001	**FW Upgrade**	**S**		Firmware upgrade data is being read from a tape.
8025	**FW Read Fail**	**E**	**F**	A firmware upgrade failed because of an error in reading data from the tape. *Action:* Try again. If it still fails, call for service.
8027	**FW Tape Write Protected**	**E**	**F**	A firmware upgrade failed because the tape is write-protected. *Action:* Change the write-protect switch on the tape and try again.
8026	**FW Write Fail**	**E**	**F**	A firmware upgrade failed because of an error in writing a modified upgrade count to the tape. *Action:* Try again. If it still fails, call for service.
2002	**Insert Mag**	**S**		The autoloader is waiting for you to insert a magazine.
8003	**Load Fail: Try New Tape**	**E**	**F**	A load command has failed, or a load or change partitions command has failed to read the System area of the tape, whcih stores information about tape usage. *Action:* Use a new cartridge.
8007	**Load Fail: Press Eject**	**E**	**F**	A load command has failed, or a load or change partitions command has failed to read the System area of the tape, whcih stores information about tape usage. *Action:* Press the Eject button.
1021	**Load Lock**	**I**		Manual loading is locked (PREVENT MEDIA REMOVAL is in operation)
2009	**Load Tape**	**I**		This is displayed when you press the Load Cartridge button.
1003	**Loading**	**S**		Either a cartridge is being moved from the magazine and placed into the drive mechanism, or the drive is loading a cartridge.
1016	**Locate**	**S**		The drive is moving the tape to a point specified by the host.
1002	**Mag Check**	**S**		The autoloader is examining the magazine to determine which slots are occupied.
1001	**Mag Eject**	**S**		The autoloader is ejecting the magazine.
1006	**Mag Loaded**	**S**		A magazine is present in the autoloader and the magazine check has been carried out.
8005	**Media Removal Prevented**	**E**	**O**	An eject command has been attempted after a SCSI PREVENT MEDIA REMOVAL command has been sent by the host. *Action:* Try again when the media removal prevention has been removed. This can be achieved by the host sending a SCSI ALLOW MEDIUM REMOVAL command, or by resetting or power-cycling the autoloader.
3004	**New FW!!!!**	**S**		The firmware upgrade process has been successfully completed.
8016	**No EODmark**	**E**	**F**	The drive is trying to read what appears to be a blank tape (one with no DDS-format EOD pattern). This is probably a result of power failure while writing.
4000	**OBDR Mode**	**I/S**	**F**	The drive has switched to HP One-Button Disaster Recovery mode and is restoring the operating system.
1017	**Partition**	**S**		The drive is switching to the other partition on a two-partition tape.

#	LCD Message	Type	OAR	Meaning
8017	**Partition 1 too large**	**E**	**O**	A command to format the tape has failed because the requested size for partition 1 is too large. *Action:* Try again with a smaller partition 1, or, if possible, a longer tape.
2007	**Press Eject**	**I**		Press the Eject button.
1009	**Read**	**S**		The drive is reading data from the tape.
8012	**Read Fail**	**E**	**F**	A read has failed. The host should reposition and try again.
1013	**Rewind**	**S**		The drive is rewinding the tape to the beginning of partition.
8020	**SCSI Error**	**E**	**O**	A SCSI command error has been detected. *Action:* Check the SCSI interface connection and try again.
1012	**Search <<**	**I**		The drive is searching for a record, filemark, setmark, or BOD (Beginning of Data) towards the beginning of the tape (in SCSI terms, it is responding to a SPACE command with a negative Count field).
1011	**Search >>**	**S**		The drive is searching for a record, filemark, setmark, or EOD (End of Data) towards the end of the tape (in SCSI terms, it is responding to a SPACE command with a positive Count field).
1022	**Select Lock**	**I**		Tape selection is locked (SCSI PREVENT MEDIUM REMOVAL is in operation).
2008	**Select Tape**	**I**		This is displayed when you press the Select button and for a short time after the button is released.
0000	**Self Test**	**S**		The autoloader is performing its power-on self-test.
1007	**SemiLoaded**	**S**		A cartridge is in the drive but not loaded (the tape has not been threaded).
2003	**Stray Tape: Insert Empty Mag**	**I**		There is a cartridge in the autoloader but there is no magazine present to put it in. *Action:* Insert an empty magazine to retrieve the cartridge.
8006	**Tape Fault**	**E**	**F**	The cartridge in the drive is faulty, possibly because the tape has snapped, or the cartridge has an invalid pattern of identification holes. *Action:* Use a new cartridge and ensure that it is Media Recognition System.
1024	**Tape Full**	**E**	**O**	A READ, SPACE, WRITE or WRITE FILEMARKS command encountered EOP unexpectedly. When reading, this may mean the required data is on the next cartridge in the sequence.
8019	**Tape has DC data**	**E**	**O**	A READ command has encountered compressed data on the tape, and the drive is not currently configured to decompress data. The host may have disabled data compression, or configuration switch 2 (on the underside of the autoloader) may be off so the host's ability to control the drive's state is disabled. *Action:* Check that the host has not disabled data compression. Make sure that switch 2 is on by reconfiguring the drive using the configuration switches on the underside of the autoloader.
8013	**Tape Position Lost**	**E**	**O**	A WRITE, READ, SPACE or REWIND command has failed to complete. The tape is positioned on the far side of the bad groups of data. *Action:* Reposition and try again.
8008	**Tape Stuck**	**E**	**F**	The cartridge is stuck in the drive. *Action:* Try forcing ejection (see page 4-9). If this fails, call for service.

#	LCD Message	Type	OAR	Meaning
4002	**Unable to boot: Cleaning tape**	**I**		The system cannot boot from a cleaning cartridge.
1004	**Unloading**	**S**		Either the drive is unloading a cartridge, or a cartridge is being ejected from the drive and replaced in the magazine.
8022	**UpgradeErr**	**E**	**F**	An error occurred while upgrading the firmware.
8015	**Worn Media**	**E**	**F**	A high error rate has been detected while writing, suggesting that the tape is nearing the end of its useful life. *Action:* Copy any data you wish to keep from the cartridge onto a new cartridge and discard the old cartridge.
1010	**Write x.y**	**S**		The drive is writing data to tape. "$x.y$**:1**" is the cumulative compression ratio since power-on, or since the compression ratio was last cleared. For example, "**Write 2.1**" means a compression ratio of 2.1:1. The compression ratio is only be displayed after about 1 MB of data has been written since power-on.
8010	**Write Fail**	**E**	**F**	A WRITE, WRITE FILEMARK or ERASE command has failed. *Action:* Use a new cartridge.
8003	**Write Fail: Clean or Use New Tape**	**E**	**F**	The drive could not write to the tape, which may be worn or damaged. *Action:* Insert a cleaning cartridge to clean the tape heads, ensuring that the tape in the cleaning cartridge has not been used up (see "Head Cleaning" on page 4-9), or use a new cartridge.
8018	**Write Protected Tape**	**E**	**F**	A WRITE, WRITE FILEMARK or ERASE command has been attempted on a write-protected cartridge. *Action:* Remove the cartridge and change it to write-enabled.
8023	**Wrong FW**	**E**	**F**	The upgrade firmware is not compatible. The drive has not been programmed.

Localizing the Display (HP C5713A only)

HP C5713A autoloaders allow you to localize the LCD display so that messages are displayed in the desired language.

1 Switch on the autoloader and hold down the Select button on the front panel for five seconds to access the **Language?** feature.

2 Press the Select button to scroll through the available languages. The selected language is displayed in the LCD display.
If you select **Numeric**, messages will be displayed as numerical codes, which are defined in "LCD Messages" on page 4-11.

3 Press the Load button to store the selected language and exit the language selection utility.

To exit the language selection facility without selecting a language, press the Enter button. If the Select button is not pressed for two minutes, the drive will automatically exit the language selection facility without selecting a language.

Upgrading Firmware from Tape

The autoloader allows you to upgrade its firmware by inserting a Firmware Upgrade tape. In order to do this, proceed as follows. The process will take at least 3 minutes to complete.

Caution Do not disconnect power at any time during the upgrade, or it may result in the autoloader having corrupt firmware, or no firmware at all. The autoloader will then have to be returned to the factory.

Note
- If the firmware upgrade is incompatible with your hardware, no upgrade will take place. The LCD will show the message "`Wrong FW`", the upgrade cartridge will be returned to the magazine, and the magazine ejected.
- The upgrade tape must not be write-protected.
- The upgrade tape can only be used a certain number of times. After that, an autoloader or drive will reformat it for normal data use, although given the amount of use it will have had, it is not advisable to use it for data.
- You cannot otherwise convert a firmware upgrade tape for normal data use.

1 Ensure that the drive is not engaged in any SCSI activity (the Tape Activity light is off and the host is not going to be accessing the drive).

2 Place the Firmware Upgrade tape into magazine slot 1, and insert the magazine into the autoloader.

3 Use the front panel Select button to select magazine slot 1.

4 Press the Load Tape button to load the upgrade tape into the drive. The autoloader will then automatically upgrade the firmware. *It is critically important that you do not power down the drive during this.*

5 When the LCD shows the message "`New FW!!!`", the firmware has been successfully upgraded and the upgrade tape has been returned to the magazine. Press the Eject button to eject the magazine. Remove the Firmware Upgrade tape, and replace it in its box.

Upgrade Tapes for Multiple Drives

From late 1995, autoloaders and drives will begin to be able to support tapes that contain upgrades for more than one drive. When the upgrade tape is inserted, the drive reads successive upgrades from the tape until it reaches one that matches its hardware. It will then upgrade the firmware. The whole process will take about 15 seconds longer for each upgrade version that needs to be skipped.

If you insert a tape with multiple upgrade versions into an autoloader or drive that does not support tapes of this kind, the device will only look at the first upgrade version on the tape. If this matches its hardware, the device will update the firmware. If it does not match, the tape will be rejected.

Self-Test

During power-up, the autoloader executes a self-test diagnostic sequence to test the electronics for functionality. This is shown by all three lights flashing at a rate of 2 Hz (twice a second). If the self-test fails, the Operator Attention Required light changes to steady amber and the other lights extinguish. The results of these tests are reported to the host through the SCSI RECEIVE DIAGNOSTICS command.

Replaceable Parts

The autoloader is a single field replaceable unit (FRU). In the event of a problem with any of the sub-assemblies in the unit, the whole unit should be replaced.

5

Cartridges

DDS Formats

The DDS (Digital Data Storage) formats build on the DAT (Digital Audio Tape) format to meet the more stringent needs of computer data storage. As the DDS technology has developed, so new standards have been produced, each allowing more data to be stored on a single cartridge.

Briefly, the development of the DDS formats to date has been as follows:

DDS-1   DDS-1 was originally called DDS. It uses 60m and 90m cartridges, and does not allow hardware data compression.

DDS1-DC   DDS1-DC, or simply DDS-DC, extended DDS-1 to include hardware data compression. This can typically double the capacity of a tape.

DDS-2   DDS-2 includes the features of DDS-1 and DDS-DC, but increases the amount of data that can be written to a single cartridge in two ways:
           ■ It uses longer, thinner tapes (120m).
           ■ It writes data in narrower tracks

           Together these features mean that a DDS-2 tape can hold twice the data of a DDS-1 90m tape.

DDS-3   DDS-3 stores data at twice the density of DDS-1 and DDS-2, and also allows more of the tape to be used for data. As a result, a DDS-3 (125m) tape holds three times the data of a DDS-2 tape.

DDS-4   DDS-4 tape, at 150m, is longer than DDS-3 (125m) tape. It holds holds two-thirds again as much data as a DDS-3 tape.

These formats are described in much more detail in Chapter 3 of *Background to DDS Products* (Volume 4 of the HP DDS Technical Manual).

Choosing Cartridges

To exploit the full potential of a DDS-format drive, you should use matching cartridges—DDS-1 cartridges for DDS-1 drives, DDS-2 cartridges for DDS-2 drives and DDS-3 cartridges for DDS-3 drives. This will allow the drives to store the maximum amount of data on a tape.

However, HP DDS drives are backward compatible. This means that, for example, a DDS-2 drive can read and write DDS-1 tapes. Note that it will use DDS-1 format, so the full advantage of DDS-2 will be lost.

Drives are not forward compatible, so, for example, a DDS-2 drive cannot read or write a DDS-3 tape. It will simply eject it.

The following table summarizes which drive can write and read which tapes. The capacities given are those that can typically be obtained using data compression (DC) where possible. They assume a compression ration of 2:1. Capacities are for a single cartridge.

	Cartridge Types				
	DDS-1 (60m)	DDS-1 (90m)	DDS-2 (120m)	DDS-3 (125m)	DDS-4 (150m)
HP C1534A	*Yes* (not DC) 1.3 GB	*Yes* (not DC) 2 GB	*No*	*No*	*No*
HP C1536A	*Yes* 2.6 GB	*Yes* 4 GB	*No*	*No*	*No*
HP C1533A HP C1539A HP C1553A	*Yes* 2.6 GB	*Yes* 4 GB	*Yes* 8 GB	*No*	*No*
HP C1537A HP C1557A	*Yes* 2.6 GB	*Yes* 4 GB	*Yes* 8 GB	*No* 24 GB	*No*
HP C5683A HP C5713A	*No*	*Yes* (read only) 4 GB	*Yes* 8 GB	*Yes* 24 GB	*Yes* 40 GB

> *Yes* = cartridge can be read and written to in the format of the tape, unless stated otherwise
>
> *No* = cartridge will be ejected, and so can neither be read nor written to

DDS-Logo Media

To identify computer-grade DDS media easily, look for the DDS logos. These indicate that the media meets the DDS specifications laid down by the ECMA, ISO/IEC and ANSI standards (see chapter 1).

The DDS-1, DDS-2 and DDS-3 logos are show in figure 5.1.

Figure 5.1 DDS logos

DDS/DDS-1 Logo

DDS-3 Logo

DDS-2 Logo

DDS-4 Logo

The *Media Recognition System* (MRS) enables drives to identify DDS-grade media. DDS MRS cartridges have a series of stripes on the transparent leader at the beginning of the tape. HP drives can be configured to treat non-MRS tapes as write-protected. In other words, the drive will only be allowed to read non-MRS cartridges, not write to them.

DDS-1 MRS tapes can be recognized by the logo in figure 5.2. MRS is used on all DDS-2 and DDS-3 tapes with the logos shown in figure 5.1.

Figure 5.2 DDS Media Recognition System logo

Media Recognition System

Cartridges with the old DDS-1 logo (as shown in figure 5.1) are in no way inferior; they simply do not carry the stripes on the leader tape, so the drive cannot recognize them as DDS quality. All DDS cartridges produced from early 1993 should have the Media Recognition System stripes. HP cartridges have the same part numbers as before. In order to configure the drive to write to the old DDS cartridges (figure 5.1), see "Configuration Switches" on page 2-9.

Prolonging Head Life

Drives are optimized to achieve the best performance possible and a typical head life in excess of 6000 hours. This figure assumes that you use the appropriate tape for the drive (such as DDS-4 media with DDS-4 drives), and that you follow a typical usage pattern.

You may not attain the typical head life when:

■ You use an older tape format, such as DDS-2 tapes with a DDS-3 drive.
■ A large proportion of cartridges loaded are being used for the first time.

Write-Protecting a Cartridge

Caution The Tape log, which contains a history of usage of the tape, is updated during the unload procedure. If the cartridge is write-protected, the Tape log will not be updated, and so will be inaccurate. Note that HP C1534A and HP C1536A drives with firmware revision T503 do *not* update the Tape log during unload.

Cartridges can be write-protected by sliding the tab on the rear of the cartridge so that the hole is open. In this state, data can be read from the tape but not written to it.

Figure 5.3 Write-protecting a cartridge

WRITE
Cartridge
write-enabled

READ-ONLY
Cartridge
write-protected
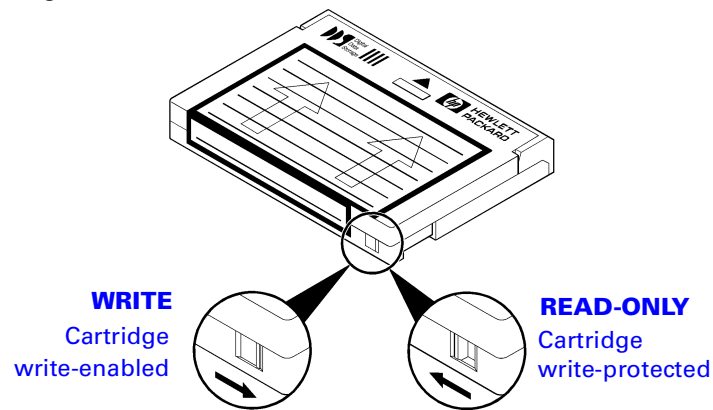
Life-Expectancy of Tapes

All DDS-certified media is electronically checked to withstand at least 2000 passes. Under optimum environmental conditions (50% relative humidity, 22°C), this is equivalent to about 100–150 backup operations. This takes into account that an area of tape may have several passes during a backup, either because streaming cannot be maintained, or because the backup software package repeatedly accesses certain areas of tape.

Under certain extreme conditions, the recommended maximum number of backup operations is less. These conditions are as follows:

- *Environmental Conditions:* Sustained use at the low end of the humidity specification will reduce the tape life.
- *Computer Performance:* The lower the performance of the computer, the more likely that streaming cannot be maintained and that an increase in the number of passes over given areas of tape will occur.
- *Backup Software Package:* The backup package may access certain areas of tape frequently, or there may be a high system overhead that may cause streaming to stop. Both of these factors increase the number of tape passes in a given area.

Because these parameters vary from system to system, it is difficult to give a definitive statement of the number of backup operations achievable using a particular tape.

As a guideline we recommend that you limit the use of a tape to around 75 backup operations in worst-case conditions of the following:

- *Environment:* sustained low humidity
- *Computer Performance:* streaming failures
- *Backup Software Package:* accessing certain tape areas frequently, or causing streaming failure

Humidity

To avoid condensation problems, allow a tape to stabilize after it has been moved from one temperature and humidity to another for at least two hours before you use it.

Using Labels

Cartridge and magazine labels must be firmly stuck to the recessed label area and nowhere else. To avoid a mechanism jam, observe the following recommendations:

- Labels must be firmly stuck and not peeling off or curling at the corners.
- Labels must only be stuck within the label area.
- A label must not be stuck on top of another label.
- Only use the labels that are supplied with the cartridges or magazine.

Figure 5.4 Magazine label area

Only stick a label here
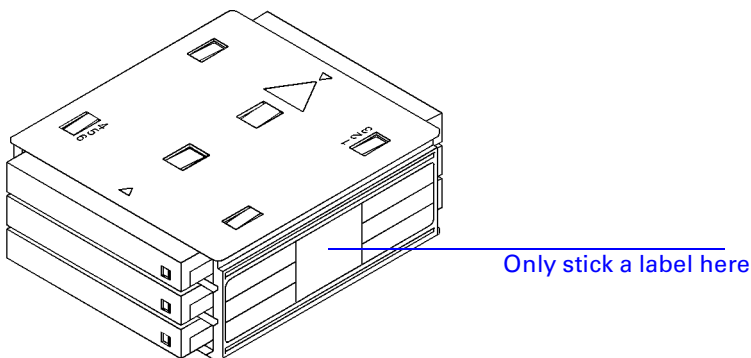
6

This chapter contains a few hints for approaching troubleshooting, together with a detailed description of the emergency procedure that a qualified service engineer can use to retrieve a magazine or cartridge from an autoloader in the event of a jam.

For details of error messages displayed on the front panel LCD of an autoloader, see .

Troubleshooting

General Procedure

If a problem occurs, the first step is to try to establish whether the problem lies with the cartridge, the drive, the host computer and connections, or the way the system is being operated.

■ *Has the system just been installed?*

There could be an installation problem:

1 Check through the information in Chapter 2.
2 Check the power connectors and SCSI cabling.
3 Is the SCSI ID correctly set? Is there a SCSI system conflict?
4 Has the SCSI bus been correctly terminated?
5 Have the configuration switches been set correctly for your system?
6 Check the environmental conditions against the specified limits.
7 Are appropriate drivers and application software installed on the host?

■ *Are you using new cartridges or a different brand of cartridge? Have you been using the particular cartridge for a very long time?*

The problem could lie with the cartridge:

1 Check through Chapter 5.
2 Check that you are using a DDS-labeled cartridge—not a DAT cartridge.
3 DDS-2 media will be ejected by DDS-1 and DDS-DC drives (HP C1534A and HP C1536A).
4 DDS-3 and DDS-4 media will be ejected by DDS-1, DDS-DC and DDS-2 drives (HP C1534A, HP C1536A, HP C1533A, HP C1539A and HP C1553A).
5 DDS-4 media will be ejected by DDS-3 drives (HP C1537A and HP C1557A).
6 Are you trying to write to non-MRS media? Check the configuration switches.
7 Has the cartridge been write-protected?
8 Clean the tape heads with the cleaning cartridge.
9 Try the operation again.
10 If the problem still occurs, try using a different cartridge.
11 If the problem is still there, the problem probably lies with the drive or the host computer.

■ *Has the drive been moved recently? Have any cables been disconnected and reconnected? Has the environment changed—unusually hot, cold, damp or dry? Has there been dust or dirt near the drive. Have reasonable precautions against static been taken?*

The problem could lie with the drive:

1 Check the cables and connectors.
2 Clean the tape heads with the cleaning cartridge.
3 If the problem persists, check the environmental conditions against the specified limits. Perhaps move the drive to a more suitable site.

■ *Has a new operating system been installed in the host computer? Has new backup software been installed.*

The problem could lie with the host or the software. Consult the computer's operating manuals, the software manual, or seek help from a service engineer.

Emergency Removal of a Magazine or Cartridge *(autoloaders only)*

Caution   This procedure should only be performed by a qualified service engineer. Considerable care is required and full anti-static precautions must be taken. Warranty conditions may be violated.

In the event of a mechanical jam, the LCD will display "`Error X`". If the actions proposed on page 4-12 fail to clear the jam, and if you must remove the magazine or cartridge, then use the following procedure.

1   Power down the system and remove the autoloader. Place it upside down on a bench.

2   Unscrew the securing bracket at the rear of the autoloader that fixes the drive mechanism in the autoloader (2 screws)—see figure 6.1.

Note   You cannot remove the bracket fully until after step 3.

Figure 6.1   Rear view, removing the securing bracket and drive

3   Gently pull upwards on the drive mechanism by gripping the SCSI connector. The drive will rotate up, pivoting from the front face—see figure 6.2. As the drive starts to pivot, it reaches a position where you can remove the securing bracket.

Figure 6.2   Rear view: lifting the drive and removing the magazine

front face
of drive

4 After removing the bracket, rotate the drive fully forward, exposing the magazine area. Remove the magazine by gently lifting it away from the spring loaded pusher bar. This is located on the right side looking from the rear.

5 If a cartridge remains jammed in the drive, proceed as follows:

a Disconnect the red interface cable from the pivoted front face of the drive (the DAI interface cable)—see figures 6.2 and 6.3.

b Remove the top lid of the drive mechanism (4 screws).

c Insert a 1.5 mm hexagonal key or a small crosspoint (Posidrive 0) screwdriver into the aperture on the right side of the drive looking from rear. This gives you access to the motor worm wheel, as shown in figure 6.3. Turn the hexagonal key or small crosspoint screwdriver *anticlockwise* to release the cartridge—this may take more than 1000 turns.

Figure 6.3 Turning the motor worm wheel to release the cartridge

Red interface cable connects here

front face of drive
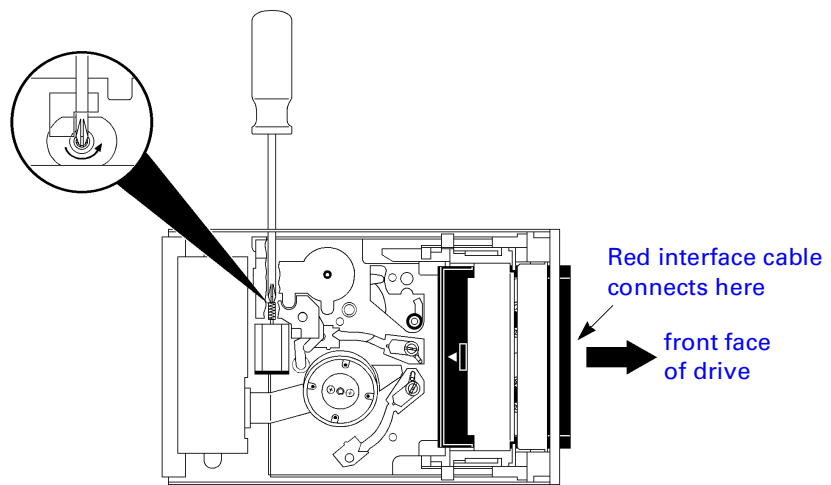
4 To reassemble the autoloader, the steps are almost the reverse of the above procedure:

a Place the lid correctly on the drive mechanism and attach it with the four screws while pushing down gently.

b Fit the front of DAT drive under the pivot points.

c Connect the red interface cable.

d Rotate the drive back into position and, when you reach the point mentioned in step 3, insert the securing bracket.

e Push the drive fully home.

f Insert the two screws into the securing bracket at the rear and tighten them—see figure 6.1.

7

Interface Implementation

The SCSI Interface

The drives use SCSI-2 as the interface to connect to the host system.

Note Throughout this chapter, the term SCSI implies SCSI-2.

The SCSI implementation provides the drives with a standard set of features and functions. These include the following:

- *DDS-'1, DDS-2, DDS-3 drives:* Single-ended narrow SCSI connection
- *DDS-4 drives:* LVD/single-ended multi-mode SCSI
- Synchronous data transfers
- Asynchronous data transfers
- Implementation of all mandatory and most optional commands of the Sequential Access command set
- *Autoloaders only:* Full implementation of mandatory Medium Changer commands

More detailed information on the SCSI interface can be found in the documents listed in Chapter 1.

Supported Messages

The following messages are supported:

00h	COMMAND COMPLETE
01h	EXTENDED MESSAGE—SDTR and WDTR*
02h	SAVE DATA POINTER
03h	RESTORE POINTERS
04h	DISCONNECT
05h	INITIATOR DETECTED ERROR
06h	ABORT
07h	MESSAGE REJECT
08h	NO-OP (NO OPERATION)
09h	MESSAGE PARITY ERROR
0Ah	LINKED COMMAND COMPLETE
0Bh	LINKED COMMAND COMPLETE (with flag)
0Ch	BUS DEVICE RESET
8Xh	IDENTIFY**

* For DDS-1, DDS-2 and DDS-3 drives, EXTENDED MESSAGE (01h) is only supported with the Extended Message Code of 01h, SYNCHRONOUS DATA TRANSFER REQUEST. All drives support both synchronous and asynchronous data transfer, and no vendor-unique codes are implemented.

** The IDENTIFY message (80h–FFh) is only supported for the values 80h and C0h.

Supported Status Codes

The following status codes are supported:

00h   GOOD
02h   CHECK CONDITION
08h   BUSY
10h   INTERMEDIATE GOOD
18h   RESERVATION CONFLICT

Supported Commands

The following commands are supported. They include all Mandatory and Extended commands and most Optional commands

Opcode	Command	Description
00h	TEST UNIT READY	Checks if the drive is ready.
01h	REWIND	Tells the drive to position the tape at the beginning of the currently active partition.
02h	REQUEST BLOCK ADDRESS	*Not HP C1534A/36A:* Returns a count representing the current logical block address to the host. A block is of fixed or variable length depending on the Fixed bit in the WRITE command. Blocks are numbered sequentially, starting with 1 at BOM. Each block, filemark, or setmark adds one to the count from BOM.
03h	REQUEST SENSE	Tells the drive to transfer sense data to the host.
05h	READ BLOCK LIMITS	Instructs the drive to return its limits for record length.
07h	INITIALIZE ELEMENT STATUS	*Autoloaders only:* ensures that the data about the status of internal elements (magazine slots and the drive) is available for READ ELEMENT STATUS.
08h	READ	Transfers one or more data records to the host, starting with the next record on the tape.
0Ah	WRITE	Transfers one or more records from the host to the current logical position on the tape.
0Ch	SEEK BLOCK	*Not HP C1534A/36A:* Positions the tape in a specified position in the current partition. When there is no exception condition during command execution, the tape is placed at the BOP side of the block specified in the Block Address field.
10h	WRITE FILEMARKS	Tells the drive to write a specified number of filemarks starting at the current logical position on the tape.
11h	SPACE	Instructs the drive to perform a variety of positioning functions, spacing over a specified number of records, filemarks, setmarks, or to EOD.
12h	INQUIRY	Tells the drive to return basic operating parameter information to the host.
13h	VERIFY	Verifies one or more records beginning with the next record on the tape. The verification only checks records on the tape. No data is transferred between the host and the drive.
15H	MODE SELECT	Allows the host to configure the drive, setting Immediate Mode, Read-after-Write, C3 Error Correction, N-Group Writing, managing the number and size of partitions, and changing the active partition. (N-Group writing is not supported on the HP C1537A.)

Opcode	Command	Description
16h	RESERVE UNIT	Reserves the drive for the exclusive use of the initiator or for another specified SCSI device.
17h	RELEASE UNIT	Releases the drive if it is currently reserved by the initiator. Third-party release is supported.
19h	ERASE	Erases part or all of the remaining data within a partition, beginning at the current logical position.
1Ah	MODE SENSE	Allows the drive to report its current configuration.
1Bh	LOAD/UNLOAD	Tells the drive to load or unload a cartridge. Unload-at-EOD and retensioning are not supported.
1Bh	Enhanced LOAD/ UNLOAD	*Autoloaders only:* A vendor-unique version of LOAD/UNLOAD, which allows hosts that do not support different LUNs and the Medium Changer command set to operate with the autoloader. It allows the host to specify the magazine slot to use.
1Ch	RECEIVE DIAG RESULTS	Tells the drive to send analysis data to the host after completion of a SEND DIAGNOSTIC command.
1Dh	SEND DIAGNOSTIC	Requests the drive to perform diagnostic tests. If the tests fail, CHECK CONDITION status indicates the results are available through the REQUEST SENSE command.
1Eh	PREVENT MEDIA REMOVAL	Allows the host to control whether the drive can eject a tape cartridge.
1Eh	Enhanced PREVENT MEDIA REMOVAL	*Autoloaders only:* A vendor-unique version of PREVENT MEDIA REMOVAL, which also allows the host to control whether the magazine can be removed.
1Fh	MEDIA CENSUS	*Autoloaders only:* A vendor-unique command returning information on which magazine slots contain cartridges.
2Bh	LOCATE	Moves the current logical position to a new position specified by the host.
34h	READ POSITION	Returns the drive's logical position to the host.
3Bh	WRITE BUFFER	Used in conjunction with the READ BUFFER to test the buffer and the SCSI bus integrity.
3Ch	READ BUFFER	Used after a WRITE BUFFER command to test the data buffer and the SCSI bus integrity.
4Ch	LOG SELECT	Allows the host to clear one or more log pages in the drive.
4Dh	LOG SENSE	Allows the host to retrieve information from the drive's logs.
A5h	MOVE MEDIUM	*Autoloaders only:* Allows the host to request that a cartridge is moved from the magazine to the drive, or from the drive to the magazine.
B8h	READ ELEMENT STATUS	*Autoloaders only:* Allows the host to find the status of the internal elements (magazine slots and the embedded tape drive).

Supported Mode Pages

The following Mode pages are supported:

	Mode Page
02h	Disconnect-Reconnect
0Fh	Data Compression Characteristics *(not HP C1534A)*
10h	Device Configuration
11h	Medium Partitions
1Ch	TapeAlert *(HP C1539A, DDS-3 and DDS-4 drives only)*
1Dh	Element Address Assignment *(autoloaders only)*
1Fh	Device Capabilities *(autoloaders only)*

Supported Log Pages

The following Log pages are supported:

	Log Page
02h	Write Error Counters
03h	Read Error Counters
2Dh	Reserved *(DDS-3 and DDS-4 drives only)*
2Eh	TapeAlert log *(HP C1539A, DDS-3 and DDS-4 drives only)*
30h	Tape Log
31h	Tape Capacity Log
32h	Buffer Trace Log
33h	Device Trace Log
34h	Write Frames Error Counters
35h	Read Frames Error Counters
36h	Bad Group Log
37h	Drive Counters
38h	Mechanism Counters
39h	Data Compression Log *(not HP C1534A)*
3Ah	Data Compression Trace Log *(not HP C1534A)*
3Bh	Channel Trace Log
3Ch	Autoloader Trace Log *(autoloaders only)*
3Dh	Autoloader Retry Counters *(autoloaders only)*
3Eh	Read Retry Log *(HP C1539A, DDS-3 and DDS-4 drives only)*

8

Physical and Safety Specifications

Dimensions and Weight

The overall dimensions of drives are as follows:

Height: 41.3 mm (1.6 in.)

Depth: 150 mm (5.9 in.)

Width: 101.6 mm (4.0 in.)

The overall dimensions of the autoloader without the front panel are as follows:

Height: 82.6 mm (3.25 in.)

Depth: 203.2 mm (8.0 in.)

Width: 146.1 mm (5.75 in.)

Weight

HP C1533A, HP C1537A: 1 kilogram (2.2 lb), without a cartridge.

HP C1534A, HP C1536A: 0.66 kilogram (1.5 lb), without a cartridge.

HP C1539A: 0.685 kilogram (1.5 lb), without a cartridge

HP C5683A: 0.716 kilogram (1.58 lb), without a cartridge

HP C1553A, HP C1557A 2.2 kilogram (4.8 lb), without a magazine

HP C5713A: 1.989 kilogram (4.38 lb), without a magazine

Orientation (Autoloaders only)

The autoloaders are designed to operate in two orientations as shown in figure 8.1:

Figure 8.1 Operating orientations
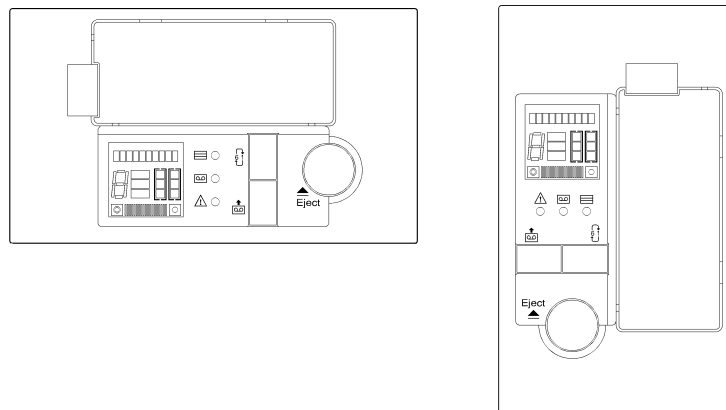
As a special order, the HP C1553A can be supplied for use in the vertical orientation with a different front panel that has the icons and LCD rotated.

Environmental

These specifications are for the drive or autoloader, not for any particular DDS-format cartridge. If a cartridge is used which has more stringent requirements than these specifications, the cartridge's requirements should be observed.

Parameter		Specification	
Ambient Temperature	*Operating*	5°C to 40°C (ΔT<10°C/h)	
	Non-Operating	−40°C to 70°C (ΔT<20°C/h)	
Humidity	*Operating*	20 to 80% RH, non-condensing Maximum wet bulb temperature = 26°C (ΔRH<30%/h)	
	Non-Operating	5 to 95% RH (ΔRH<30%/h)	
Vibration	*Operating (3 axes for drives, 1 axis for autoloaders)*	Swept Sine:	0.3 g peak, 5–500 Hz @ 1 octave/min
		Random:	5–350 Hz @ 0.00053 g^2/Hz 350–500 Hz @ -6 dB/octave 500 Hz@ 0.000271 g^2/Hz ($\approx$0.5 g rms)
	Non-Operating (3 axes)	Swept Sine:	0.75 g peak, 5-500 Hz @ 1 octave/min
		Random:	5–100 Hz @ 0.020 g^2/Hz 100–137 Hz @ -6 dB/octave 137–350 Hz @ 0.0107 g^2/Hz 350–500 Hz @ -6 dB/octave 500 Hz @ 0.0052 g^2/Hz ($\approx$2.41 g rms)
Shock	*Operating (drives: 3 axes, autoloader: 1 axis) no performance change*	5.0 g peak for 3 ms: half sine	
	Operating (drives: 2 axes, 3 faces, autoloader: 1 axis) no data loss	8.0 g peak for 11 ms: half sine	
	Non-Operating (6 faces) no damage	90.0 g peak for 3 ms: half sine 30.0 g peak for 26 ms: trapezoidal	
Altitude	*Operating*	0 km to 4.6 km (0 to 15,000 ft)	
	Non-Operating	0 km to 15.2 km (0 to 50,000 ft)	
Transportation *Type 1:* One drive packaged individually, also ten drives packaged together	Vibration *Type 1 package (3 axes)*	Swept Sine:	0.5 g peak @ 5–200–5 Hz @ 1 octave/min 5 min dwell at peak resonance
		Random:	5–100 Hz @ 0.015 g^2/Hz 100–200 Hz @ -6 dB/octave 200 Hz @ 0.0038 g^2/Hz ($\approx$1.47 g rms) (30 min/axis)
	Impact *Type 1 package*	10 vertical impacts (6 faces and 4 bottom package corners from 910 mm height for a single drive, 760 mm for ten packaged together)	
Suspended Particles	*Operating and Non-Operating*	Suspended particle environment, particles <200 microgram/cubic meter	
Acoustic Noise Emissions		<5.0 bel soundpower	

Electromagnetic Compatibility

The EMC performance of internal autoloaders depends on the characteristics of the system in which the autoloader is installed. Hewlett-Packard has tested internal autoloaders installed in network servers and in external desktop enclosures to verify EMC performance against existing regulatory standards. Hewlett-Packard will also ensure that internal autoloaders will comply with new regulatory standards by or before their date of implementation.

	Implementation Date	European Economic Area Standards	International Standards
Radiated and Conducted Emissions			
	before 1 Aug 2001:	EN 55022:1994 + Amendment A1:1995 + Amendment A2:1997	CISPR 22:1993 + /A1:1995 + /A2:1996
	from 1 Aug 2001:	EN 55022:1998	CISPR 22:1997
Harmonic Current Emissions			
	before 1 Jan 2001:	EN 60555-2:1987	IEC 60555-2:1982 + A1:1985
	after 1 Jan 2001:	EN 61000-3-2:1995 + Amendment A1:1998 + Amendment A2:1998	IEC 61000-3-2:1995 + /A1:1997 + /A2:1998
Voltage Fluctuations and Flicker			
	before 1 Jan 2001:	EN 60555-3:1987	IEC 60555-3:1982
	after 1 Jan 2001:	EN 61000-3-3:1995	IEC 61000-3-3:1994
Immunities			
	before 1 Jul 2001:	EN 50082-1:1992	IEC 801-2:1991 IEC 801-3:1984 IEC 801-4:1988
	after 1 Jul 2001:	EN 55024:1998	CISPR 24:1997 IEC 61000-4-2:1995 IEC 61000-4-3:1995 IEC 61000-4-4:1995 IEC 61000-4-5:1995 IEC 61000-4-6:1996 IEC 61000-4-8:1993 IEC 61000-4-11:1994

Media Specifications

Parameter		Specification
Storage	*Temperature* *Humidity* *Wet Bulb Temp*	5°C to 32°C 20%RH to 60%RH 26°C max
Transportation (recommended)	*Temperature* *Humidity* *Wet Bulb Temp*	−40°C to 45°C 5%RH to 80%RH 26°C max

Power Requirements

The power requirements are as follows:

- **+5V**: ±5%, Ripple <150 mV peak-peak (<100 mV peak-peak for the HP C1533A and HP C1553A)
- **+12V**: ±10% (±5% for drives other than the HP C1537A when programming EEPROM), Ripple <150 mV peak-peak

On powering up, both supplies should come up within 1 second of each other.

On powering down, the 12V supply should be maintained within ±10% limit until the 5V supply drops below 4.5V.

The specified ratings are as follows:

		+5V supply	+12V supply	Power
HP C1534/36A	*Typical Operation*	0.6A	0.12A	< 5W
	Worst Case Peaks (<1s)	0.8A	0.4A	8.8W
HP C1533A	*Typical Operation*	< 1.2A	< 0.2A	7.5W
	Worst Case Peaks (<1s)	1.2A	0.8A	15.6W
HP C1537A	*Typical Operation*	0.95A	< 0.06A	5.7W
	Worst Case Peaks (<2s)	095A	0.51A	10.2W
HP C1539A	*Typical Operation*	<0.65A	0.03A	3.8W
	Worst Case Peaks (<1s)	1.0A	0.3A	6.1W
HP C5683A	*Typical Operation*	0.5A	0.4A	7.3W
	Worst Case Peaks (<1s)	0.85A	1.2A	20.3W
HP C1557A (embedded drive)	*Typical Operation*	<1.2A	0.25A	9W
	Worst Case Peaks (<1s)	1.2A	0.8A	15.6W
HP C5713A (embedded drive)	*Typical Operation*	0.5A	0.4A	7.3W
	Worst Case Peaks (<1s)	0.85A	1.2A	20.3W

For the HP C1553A, the ratings for the embedded drive are the same as for the HP C1533A above.

The ratings for the changer mechanism in the autoloaders are as follows:

		+5V supply	+12V supply	Power
Changer Mechanism	*Typical Operation*	<0.75A	<0.25A	6.8W
	Worst Case Peaks (<1s)	0.75A	2.0A	28W

Measured values of current for typical units are as follows:

	HP C1534A/36A		HP C1533A		HP C1537A		HP C1539A		HP C5683A	
	5V	12V	5V	12V	5V	12V	5V	12V	5V	12V
Idle	0.6A	10 mA	1.1A	0.1A	0.6A	0.05A	0.47A	0.02A	0.18A	0.19A
Reading/Writing	0.6A	0.12A	1.16A	0.12A	0.85A	0.06A	0.65A	0.03A	0.5A	0.4A
Load/Unload *(peak, <0.5s)*	0.7A	0.32A	1.12A	0.6A	0.66A	0.51A	0.48A	0.06A	0.36A	1.07A
Fast Forward/Reverse	0.6A	0.25A	1.1A	0.4A	0.74A	0.21A	0.64A	0.03A	0.85A	1.2A

For the HP C1553A, measured values of overall current for typical units are as follows:

- **+5V**: between 1300 mA and 1400 mA with no significant spikes.
- **+12V**: shown in figures 8.2 and 8.3.

The drives are protected by internal fuses.

Figure 8.2 HP C1553A autoloader: typical overall current
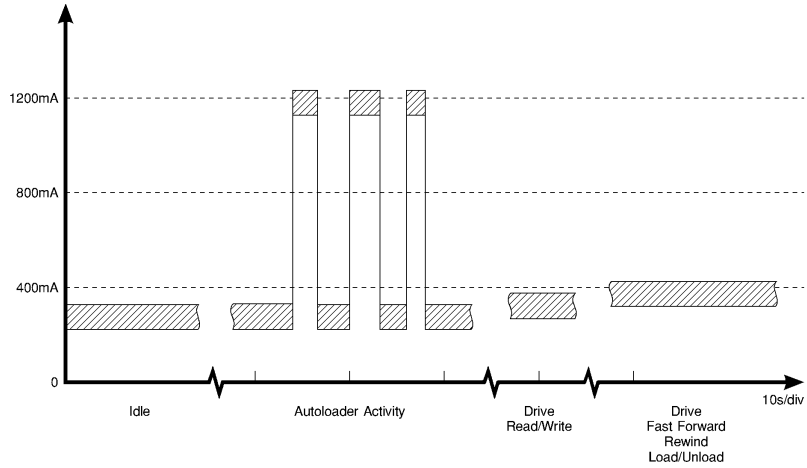
Figure 8.3 HP C5713A autoloader: typical overall current
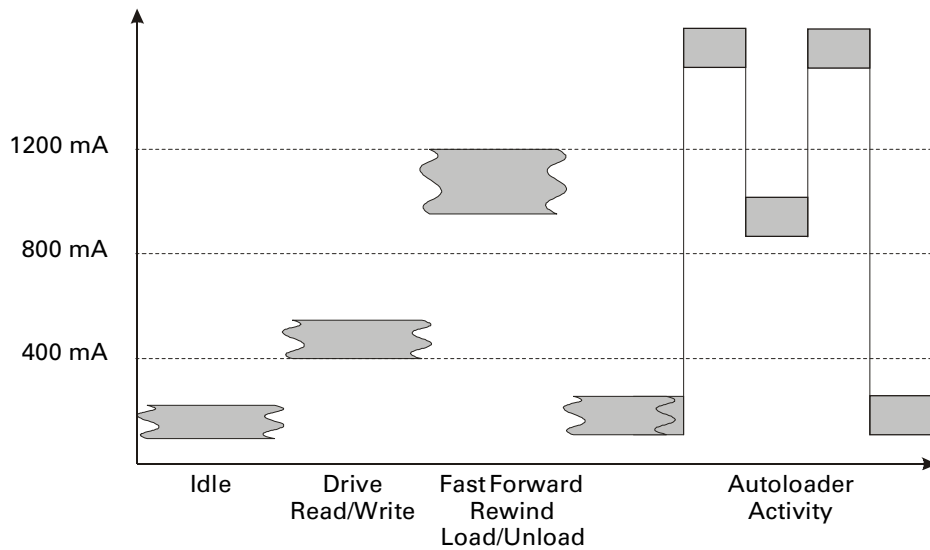
Safety

All HP DDS drives conform to the following safety standards:

■ UL 1950—"*Safety of Information Equipment, Including Electrical Business Equipment*" (Second Edition).

■ CSA C22.2 Number 950, M1986—"*Safety of Information Equipment, Including Electrical Business Equipment*".

■ TUV EN60 950: "*Safety of Information Technology Equipment including Electrical Business Equipment*" (1992 + A1 + A2:1993)

■ IEC 950—"*Safety of Information Technology Equipment including Electrical Business Equipment*"

Conditions of Acceptability

Use the drives only in equipment where the suitability of the combination has been determined by an appropriate certification organization (for example, Underwriters Laboratories Inc. or the Canadian Standards Association in North America, and the British Standards Institution or Verband Deutscher Elektrotechniker in Europe).

Other considerations include the following:

■ A drive must be installed in an enclosure to limit an operator's access to live parts, to provide system stability, and to give the drive the necessary grounding integrity.

■ A drive must only be supplied by a Safety-Extra-Low-Voltage (secondary) circuit in accordance with DIN VDE 0805. During incorporation of the equipment, all requirements of DIN VDE 0805 must be observed and obeyed

Note The drives are only fused to protect them from excessive currents.

9

Reliability

Summary

The following table summarizes the reliability specifications of the drives. Each measure is described in the sections that follow.

Parameter	HP C1534A	HP C1536A	HP C1533A	HP C1553A	HP C1537A	HP C1539A	HP C1557A	HP C5683A	HP C5713A
MTBF *Hours:* *Duty cycle:*	200,000 5%	200,000 5%	200,000 12%	40,000 30%	300,000 12%	300,000 12%	55,000 30%	400,000 12%	100,000 30%
Drive Life *(tape-pulling hours)*	2,000	2,000	6,000	6,000	6,000	6,000	6,000	6,000	6,000
Cartridge Swaps	n/a	n/a	n/a	>100,000	n/a	n/a	>100,000	n/a	>100,000
Interchange Formats	DDS-1	DDS DDS-DC	DDS-1 DDS-DC DDS-2	DDS-1 DDS-DC DDS-2	DDS-1 DDS-DC DDS-2 DDS-3	DDS-1 DDS-DC DDS-2	DDS-1 DDS-DC DDS-2 DDS-3	DDS-1* DDS-DC DDS-2 DDS-3 DDS-4	DDS-1* DDS-DC DDS-2 DDS-3 DDS-4
Data Reliability Error Rate	<1 in 10^{15} bits read	<1 in 10^{15} bits read	<1 in 10^{15} bits read	<1 in 10^{15} bits read	<1 in 10^{15} bits read	<1 in 10^{15} bits read	<1 in 10^{15} bits read	<1 in 10^{15} bits read	<1 in 10^{15} bits read

* 90m DDS-1 tapes are read-only; 60m DDS-1 tapes are not supported

Note Hewlett-Packard Company does not warrant that these predicted values are representative of any particular unit installed for customer use. Failure rates are derived from a large database of test samples. The actual failure rate will vary from unit to unit.

Mean-Time Between Failures (MTBF)

The specifications assume that the integration practices recommended by CPB have been followed (see the list of related documents on). Also refer to the duty cycle given in the table above.

The method of calculation is as follows:

$$\text{MTBF} = \frac{\text{Cumulative hours of all drives shipped}}{\text{Number of units returned due to end-user failures}}$$

MTBF for the Autoloaders

Changer Life

The expected life of the changer mechanism is >100,000 cartridge swaps. This is based on a typical model of heavy usage as follows:
- The autoloader is used 5 days per week.
- There are 20 cartridge swaps per day.
- The drive performs 10 hours of tape pulling per day.

This gives 100 cartridge swaps per week and 50 hours pulling tape, which is equivalent to a 30% duty cycle for the autoloader.

A cartridge swap is defined as follows:
1 The drive rewinds the cartridge and unloads it.
2 The changer mechanism returns the cartridge to the magazine.
3 The changer selects another cartridge from the magazine and transfers it to the drive.
4 The drive loads the new cartridge.

Calculating the MTBF

For HP C1553A autoloaders, the expected MTBF is based on a figure of 80,000 hours for the changer mechanism, with the usage model described in "Changer Life" above.

The MTBF for the drive mechanism would be 200,000 power-on hours with the typical duty cycle for DDS-format drives of 12%. With the heavier 30% duty cycle within the autoloader, this reduces to 80,000 hours.

Combining these two gives an overall MTBF of 40,000 hours at a 30% duty cycle.

This is calculated as follows:

Drive: $MTBF_D$ @ 12% = 200,000 hrs
Autochanger mechanism: $MTBF_A$ @ 30% = 80,000 hrs

For the drive embedded in an autoloader:

The factor for usage in the autoloader is $\frac{30\%}{12\%} = 2.5$

so $MTBF_D$ @ 30% $= \frac{200000}{2.5} = 80000$ hours

So we now have:
$MTBF_D$ @ 30% = 80,000hrs
$MTBF_A$ @ 30% = 80,000hrs

The FPMH (Failure Rate Mechanism Hours) for the whole autoloader is the sum of the reciprocals of the individual MTBFs for drive and autochanger mechanism:

$$FPMH = \frac{1}{MTBF_D} + \frac{1}{MTBF_A} = \frac{1}{80000} + \frac{1}{80000} = 2.5 \times 10^{-5}$$

The MTBF for the whole autoloader is then the reciprocal of this FPMH:

$$MTBF = \frac{1}{FPMH} = \frac{1}{2.5 \times 10^{-5}} = 40000 \text{ hours}$$

Drive Life

The expected life of the HP C1534A/36A is equivalent to 2,000 hours of tape pulling. For the other, higher-performance drives, the expected head life is equivalent to 6,000 hours of tape pulling.

Note   The drive is designed to operate in streaming and repositioning modes. Sustained low data transfer rates may cause premature failure through an excessive number of starts and stops.

Data Interchange

According to specification, cartridges can be interchanged between drives which conform to the same DDS format.

Data Reliability

The unrecoverable error rate on read is specified as less than 1 in 10^{15} bits read.

For further details, refer to "*Designing a Data Storage Format for Digital Audio Tape (DAT)*", produced for the DDS Manufacturers Group, and available from Hewlett-Packard (see Chapter 1).

10

Performance Specification

	HP C1534A	HP C1536A	HP C1533A	HP C1537A	HP C1539A	HP C1553A	HP C1557A	HP C5683A	HP C5713A
Capacity *(2:1 compression)*									
DDS-1 60m cart.	1.3 GB*	2.6 GB	2.6 GB	2.6 GB	2.6 GB	15.6 GB	15.6 GB	n/s	n/s
DDS-1 90m cart.	2.0 GB*	4.0 GB	4.0 GB	4.0 GB	4.0 GB	24.0 GB	24.0 GB	4.0 GB[†]	24.0 GB[†]
DDS-2 120m cart.	n/s	n/s	8.0 GB	8.0 GB	8.0 GB	48.0 GB	48.0 GB	8.0 GB	48.0 GB
DDS-3 125m cart.	n/s	n/s	n/s	24.0 GB	n/s	n/s	144.0 GB	24.0 GB	144.0 GB
DDS-4 150m cart.	n/s	n/s	n/s	n/s	n/s	n/s	n/s	40.0 GB	240.0 GB
Transfer Rate									
Max. Sustained Native	183 KB/s	183 KB/s	510 KB/s	1 MB/s	510 KB/s	510 KB/s	1 MB/s	3 MB/s	3 MB/s
Max. Burst Asynch.	1.6 MB/s	1.6 MB/s	3 MB/s	3 MB/s	3 MB/s	3 MB/s	3 MB/s	6 MB/s[‡]	6 MB/s[‡]
Max. Burst Synch.	5 MB/s	5 MB/s	8 MB/s	10 MB/s	>10 MB/s	8 MB/s	10 MB/s	40 MB/s[‡]	40 MB/s[‡]
Average Cartridge Load Time	<14s	<14s	<14s	<14s	<13s	swap time + <14s	swap time + <14s	<15s	swap time + <15s
Fast Search *(average file access time)*	52s (90m)	52s (90m)	40s (DDS-2)	40s (DDS-3)	45s (DDS-2)	40s (DDS-2)	40s (DDS-2)	50s (DDS-4)	50s (DDS-4)

n/s not supported

* HP C1534A does not support data compression. These are uncompressed capacities.

[†] read-only

[‡] wide SCSI

Assumptions:

■ Tapes conform to the DDS Media Specification.

■ Tape heads are cleaned regularly using the guidelines in Chapter 3.

■ Drive and tapes are kept within environmental specifications.

■ C3 ECC frames, read-after-write, and read retries use the default settings.

■ Transfer rates are using the optimal tape type (DDS-2 tape in a DDS-2 drive, DDS-3 in a DDS-3 drive, DDS-4 tapes in a DDS-4 drive).

Data Capacity

Using data compression on the drives (except the HP C1534A), the actual capacity that can be achieved depends on the nature of the data.

Load and Unload Times

The load time is from when a cartridge is inserted to when the drive is ready to start acting upon the next host command.

The time taken to unload and eject a cartridge depends heavily on the length of tape, the number of partitions and the current position on the tape. The tape must first be rewound, which could take up to 80s for a DDS-2 tape (60s for DDS-1 90m) if EOD is near the end of the tape. The drive then updates the Tape log. Finally, the drive performs the unloading procedure. As a result, the entire eject sequence can take between 30 seconds and 2 minutes.

Note HP 1534A/36A drives with firmware version T503 do not load or save the Tape log, so their load and unload times are less.

Autoloader Swap Times

The average cartridge swap time is 15 seconds, where a swap is defined as follows:

1 The drive rewinds the cartridge and unloads it.
2 The changer mechanism returns the cartridge to the magazine.
3 The changer selects another cartridge from the magazine and transfers it to the drive.
4 The drive loads the new cartridge.

The actual time will depend on the position in the magazine.

Retries Limits on Rewrites

For Read-After-Write rewrites, each frame can be rewritten up to a maximum of 127 times (giving 128 writes of the frame). In addition, the total number of frame rewrites within one group is 128.

Power-Fail Handling

If there is a power-fail, the drive performs the following actions, and reverts to its default configuration when power is restored:

1 The drive executes the Power-Up sequence of self-tests.

2 If a tape is present, it is threaded with the usual load sequence.

3 The drive fails the next host command and returns a CHECK CONDITION status. The host should then send a REQUEST SENSE command. The drive responds with the UNIT ATTENTION sense key, and sets the Additional Sense bytes to indicate that the drive has been power-cycled.

Appendix A

Product Comparisons

The following tables compare features of HP DDS drives:

Physical

	HP 35470A	HP 35480A	HP C1534A	HP C1536A	HP C1533A	HP C1537A	HP C1539A	HP C1553A	HP C1557A	HP C5683A	HP C5713A
Form-factor	3.5"	3.5"	3.5"	3.5"	3.5"	3.5"	3.5"	5.25"	5.25"	3.5"	5.25"
Dimensions *(in mm)*											
Width:	101.6 (4.0")	101.6 (4.0")	101.6 (4.0")	101.6 (4.0")	101.6 (4.0")	101.6 (4.0")	101.6 (4.0")	146.1 (5.75")	146.1 (5.75")	101.6 (4.0")	146.1 (5.75")
Depth:	150 (5.9")	150 (5.9")	150 (5.9")	150 (5.9")	150 (5.9")	150 (5.9")	150 (5.9")	203.2 (8.0")	203.2 (8.0")	150 (5.9")	203.2 (8.0")
Height:	41.3 (1.6")	41.3 (1.6")	41.3 (1.6")	41.3 (1.6")	41.3 (1.6")	41.3 (1.6")	41.3 (1.6")	82.6 (3.25")	82.6 (3.25")	41.3 (1.6")	82.6 (3.25")
Weight *(no cartridge or magazine)*	i kg (2.2 lb)	1 kg (2.2 lb)	0.66 kg (1.5 lb)	0.66 kg (1.5 lb)	1 kg (2.2 lb)	1 kg (2.2 lb)	0.685 kg (1.5 lb)	2.2 kg (4.8 lb)	2.2 kg (4.8 lb)	0.716 kg (1.58 lb)	1.989 kg (4.38 lb)
Autochanger	No	No	No	No	No	No	No	Yes	Yes	No	Yes
Lights (LEDs)	2 bi-color	2 bi-color	2	2	2	2	2	3 + LCD	3 + LCD	2	3 + LCD
Termination resistors	Yes	Yes	No	No	No	No	No	No	No	No	No
Termination power	jumper	jumper	permanent	permanent	jumper	jumper	Yes	jumper	jumper	jumper	jumper
Humidity sensor	Yes	Yes	No	No	No	No	No	No	No	No	No

Media-Related

	HP 35470A	HP 35480A	HP C1534A	HP C1536A	HP C1533A	HP C1537A	HP C1539A	HP C1553A	HP C1557A	HP C5683A	HP C5713A
Supported media	DDS-1	DDS-1	DDS-1	DDS-1	DDS-1, DDS-2	DDS-1, DDS-2, DDS-3	DDS-1, DDS-2	DDS-1, DDS-2	DDS-1, DDS-2, DDS-3	DDS-1*, DDS-2, DDS-3 DDS-4	DDS-1*, DDS-2, DDS-3, DDS-4
MRS support	optional	optional	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hardware data compression (DCLZ)	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Format compatibility											
DDS-1:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No
DDS1-DC:	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes*	Yes*
DDS-2:	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
DDS-3:	No	No	No	No	No	Yes	No	No	Yes	Yes	Yes
DDS-4:	No	No	No	No	No	No	No	No	No	Yes	Yes
Capacity *(typical, using 2:1 data compression where supported)*											
60m DDS-1:	1.3 GB	2.6 GB	1.3 GB	2.6 GB	2.6 GB	2.6 GB	2.6 GB	15.6 GB	15.6 GB	n/s	n/s
90m DDS1-DC:	2.0 GB	4.0 GB	2.0 GB	4.0 GB	4.0 GB	4.0 GB	4.0 GB	24.0 GB	24.0 GB	4.0 GB*	24.0 GB*
120m DDS-2:	No	No	No	No	8.0 GB	8.0 GB	8.0 GB	48.0 GB	48.0 GB	8.0 GB	48.0 GB
125m DDS-3:	No	No	No	No	No	24.0 GB	No	No	144 GB	24.0 GB	144 GB
150m DDS-4:	No	No	No	No	No	No	No	No	No	40.0 GB	240 GB
Data encoding	8:10 NRZI	8:10 NRZI	8:10 NRZI	8:10 NRZI	8:10 NRZI	8:10 NRZI	8:10 NRZI	8:10 NRZI	8:10 NRZI	8:10 NRZI	8:10 NRZI
Data density on tape	61,000 bpi	61,000 bpi	61,000 bpi	61,000 bpi	61,000 bpi	122,000 bpi	61,000 bpi	61,000 bpi	122,000 bpi	122,000 bpi	122,000 bpi
Track density	1869 tpi	1869 tpi	1869 tpi	1869 tpi	2793 tpi	2793 tpi	2793 tpi	2793 tpi	2793 tpi	3738 tpi	3738 tpi

* DDS-1 60m cartridges are not supported in DDS-4 drives. 90m cartridges are read-only.

Mechanical

	HP 35470A	HP 35480A	HP C1534A	HP C1536A	HP C1533A	HP C1537A	HP C1539A	HP C1553A	HP C1557A	HP C5683A	HP C5713A
Load mechanism	reels raised	reels raised	cartridge lowered	cartridge lowered	reels raised	reels raised	cartridge lowered	reels raised	reels raised	cartridge lowered	cartridge lowered
Tension control	firmware	firmware	mechanical tension arm	mechanical tension arm	firmware	firmware	firmware/ mechanical	firmware	firmware	firmware	firmware
Independent reel motor control	Yes	Yes	No	No	Yes	No	No	Yes	No	Yes	Yes
Number of tape guides	8	8	7	7	8	8	7	8	8	7	7
Normal tape speed	8 mm/s (0.315 ips)	8 mm/s (0.315 ips)	8 mm/s (0.315 ips)	8 mm/s (0.315 ips)	15.5 mm/s (0.61 ips)	10.4 mm/s (0.41 ips)	15.5 mm/s (0.61 ips)	15.5 mm/s (0.61 ips)	10.4 mm/s (0.41 ips)	23.39 mm/s (0.92 ips)	23.39 mm/s (0.92 ips)
Fast-search tape speed *(multiple of normal speed)*	175x	175x	100x	100x	70x *(DDS-1)* 105x *(DDS-2)*	100x *(DDS-3)*	70x *(DDS-1)* 105x *(DDS-2)*	70x *(DDS-1)* 105x *(DDS-2)*	100x *(DDS-3)*	68.4	68.4
Drum speed *(reading and writing)*	2000 rpm	2000 rpm	2000 rpm	2000 rpm	5737 rpm	3825 rpm *(DDS-3)*	5737 rpm	5737 rpm	3825 rpm *(DDS-3)*	11479 rpm (DDS-4)	11479 rpm (DDS-4)
Windowless drum	No	No	Yes	Yes	No	No	No	No	No	Yes	Yes
Forced-air cooling recommended	No	No	No	No	Yes	No	No			1 cu.ft./ min	1 cu.ft./ min

Electrical

	HP 35470A	HP 35480A	HP C1534A	HP C1536A	HP C1533A	HP C1537A	HP C1539A	HP C1553A	HP C1557A	HP C5683A	HP C5713A
Power requirements	5V ±5% 12V ±10%	5V ±5% 12V ±10%	5V ± 5% 12V ± 10%	5V ± 5% 12V ± 10%	5V ± 5% 12V ± 5%	5V ±5% 12V ±5%	5V ± 5% 12V ± 10%	5V ± 5% 12V ± 10%	5V ± 5% 12V ± 10%[1]	5V ±5% 12V ±5%	5V ± 5% 12V ± 10%
5V current, typical operation	0.6A	0.6A	0.6A	0.6A	<1.2A	0.95A	<0.65A	<1.2A[2] <0.75A[3]	<1.2A[2] <0.75A[3]	0.5A	0.5A[2] <0.63A[3]
5V current, worst case peaks (<1s)	0.6A	0.6A	0.8A	0.8A	1.2A	0.95A	1.0A	1.2A[2] 0.75A[3]	1.2A[2] 0.75A[3]	0.85A	0.85A[2] 0.75A[3]
5V power supply noise & ripple, peak-to-peak	<0.15V	<0.15V	<0.15V	<0.15V	<0.1V	<0.1V	<0.15V	<0.1V	<0.1V	<0.15V	<0.15V
12V current, typical operation	0.1A	0.1A	0.12A	0.12A	<0.2A	0.06A[4]	0.03A	<0.25A[2] <0.25A[3]	<0.25A[2] <0.25A[3]	0.4A	0.4A[2] <1.12A[3]
12V current, worst case peaks (<2s)	0.6A	0.6A	0.4A	0.4A	0.8A	0.51A	0.3A	0.8A[2] 2.0A[3]	0.8A[2] 2.0A[3]	1.2A	1.2A[2] 2.0A[3]
12V power supply noise & ripple, peak-to-peak	<0.15V	<0.15V	<0.15V	<0.15V	<0.15V	<0.15V	<0.15V	<0.15V	<0.15V	<0.15V	<0.15V
Power consumption, typical operation	<5 W	<5 W	<5 W	<5 W	8.55 W	5.7W	3.8W	9W[2] 6.8W[3]	9W[2]	7.3W	7.3W[2] 16.6W[3]
Power consumption, worst case			8.8W	8.8W	15.6W	10.2W	6.1W	15.6W[2] 28W[3]	15.6W[2] 28W[3]	20.3W	20.3W[2] 29.5W[3]

[1]±5% if programming the EEPROM   [2]embedded drive   [3]changer mechanism

[4]During rewind, the typical 12V current is 0.2A for about 90 seconds

Quality and Regulatory

	HP 35470A	HP 35480A	HP C1534A	HP C1536A	HP C1533A	HP C1537A	HP C1539A	HP C1553A	HP C1557A	HP C5683A	HP C5713A
Specified MTBF *(hours at x% duty cycle)*	50,000 (12%)	50,000 (12%)	200,000 (5%)	200,000 (5%)	200,000 (12%)	300,000 (12%)	300,000 (12%)	35,000 (30%)	55,000 (30%)	400,000 (12%)	100,000 (30%)
Drive life *(tape-pulling hours)*	>6000	>6000	2,000	2,000	6,000	6,000	6,000	6000	6000	6000	6000
Changer life *(cartridge swaps)*								>100,000	>100,000		>100,000
Uncorrectable error rate	<1 in 10^{15}	<1 in 10^{15}	<1 in 10^{15}	<1 in 10^{15}	<1 1in 10^{15}	<1 in 10^{15}	<1 in 10^{15}	<1 in 10^{15}	<1 in 10^{15}	<1 in 10^{15}	<1 in 10^{15}
UL, CSA & TUV approved	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Environmental specs	HP B2	HP B2	HP B2	HP B2	HP B2	HP B2	HP B2	HP B2	HP B2	HP B2	HP B2
ITE EMC specs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Interface and Performance

	HP 35470A	HP 35480A	HP C1534A	HP C1536A	HP C1533A	HP C1537A	HP C1539A	HP C1553A	HP C1557A	HP C5683A	HP C5713A
Buffer size	1 MB	1 MB	512 KB	512 KB	1 MB	2 MB	1 MB	1 MB	2 MB	8 MB	8 MB
Transfer Rates *(maxima using the optimal cartridge type for each drive, such as DDS-2 for DDS-2 drives)*											
Sustained, native.	183 KB/s	183 KB/s	183 KB/s	183 KB/s	510 KB/s	1 MB/s	510 KB/s	510 KB/s	1 MB/s	3 MB/s	3 MB/s
Burst, asynchronous.	1.5 MB/s	1.5 MB/s	1.5 MB/s	1.5 MB/s	3 MB/s	3 MB/s	3 MB/s	3 MB/s	3 MB/s	6 MB/s‡	6 MB/s‡
Burst, synchronous.	≤5 MB/s	≤5 MB/s	≤5 MB/s	≤5MB/s	≤8 MB/s	10 MB/s	<10 MB/s	≤8 MB/s	10 MB/s	40 MB/s‡	40 MB/s‡
Mean reposition time	<2.5s	<2.5s	<3.0s	<3.0s	<2.5s	<2.5s	<3s	<2.5s	<2.5s	<2.5s	<2.5s
Mean time to fast-search *(on an xm cartridge)*	≤30s (DDS-1 90m)	≤30s (DDS-1 90m)	52s (DDS-1 90m)	52s (DDS-1 90m)	40s (DDS-2)	40s (DDS-3)	40s (DDS-2)	40s (DDS-2)	40s (DDS-3)	50s (DDS-4)	50s (DDS-4)
Power-on self-test time	<14s	<14s	<5s	<5s	<10s	<10s	<10s			<5s	<5s
Load time	<30s	<30s	<14s	<14s	<14s	<14s	<13s	<14s* 15s†	<14s* 15s†	<15s	<15s* 15s†

*loading a cartridge in the embedded drive

†average time for the changer mechanism to swap a cartridge between the magazine and the drive

‡ wide SCSI

Additional Differences

1 Minimum SCSI transfer size to guarantee streaming:

HP 35470/80A, HP C1534A/36A	5 KB	HP C1533/37/39A	6 KB	HP C5683/5713A	8 KB

The following notes concern SCSI commands:

2 *INQUIRY, Standard Inquiry Data Format page, Product Revision Level:*
The HP 35470A/80A uses a numeric format showing the basic firmware revision and the drive variant, such as "10.9". Here the basic revision level is 10, and the variant is 9. For the full firmware revision code, see the INQUIRY Firmware Revisions page (code C0h), bytes 5–29. This might show the full firmware revision as "10.7", for example.
Other HP DDS drives use an alphanumeric format giving the firmware date code. For the HP C1533A/53A, this is in the form "*yymm*", where "*yy*" is the year, and "*mm*" the month. For example, "9503" would mean March 1995.
The HP C1534A/36A use the same basic method, but the first digit of the year is replaced by the letter "T". For example, "T503" would indicate an HP C1534A/36A with firmware of March 1995.

3 LOG SENSE: The HP C1534 and HP C1536A do not support the following Log Pages:
  ❏ Read and Write Error Counters
  ❏ Write and Read Frames Error Counter Pages
  ❏ Bad Group Log Page Drive Counters
  ❏ Mechanism Counters.
For early versions of the firmware, the Tape log is not updated on unloading.

4 LOG SENSE: HP C1539A, DDS-3 and DDS-4 drives support the TapeAlert Log page and the Read Retry Log page.

5 READ BUFFER: Drive Failure Codes in EEPROM:
The HP 35470/80A return information in 10-byte slots.
The HP C1534/36A use the same format as the DDS-2, DDS-3 and DDS-4 drives and return information in 3-byte slots.

6 REQUEST SENSE: The data length is 19 bytes for the HP 35470/80A and 22 bytes for the HP C1534/36A.

7 REQUEST SENSE: Some vendor-unique drive error codes in byte 17 have different definitions for different drives.

8 MODE SELECT, Disconnect/Reconnect Page: The Bus Inactivity default value is 39h for the HP 35470/80A and 38h for the HP C1534/36A.

Glossary

ANSI American National Standards Institute, which sets standards for SCSI and the safety of electrical devices, amongst other things.

asynchronous *see* **data transfer**

autoload When a tape cartridge is inserted, a tape drive with autoload will automatically load it without the host having to send a load command. If a drive does not have autoload, the drive will take no action until it receives a load command from the host computer.

autoloader A device embodying a tape drive and a cartridge changer mechanism, housed in a single case.

block A logical unit of information. Called "record" in the DDS-format specification.

BOM Beginning Of Media. The first point on the tape that can be accessed by the drive.

BOP Beginning Of Partition. The position at the beginning of the permissible recording region of a partition.

C3 ECC A third level of error correction code covered by the DDS format. C3 allows any two tracks in a group to be corrected, and is used only when a raw data error is too big to be corrected by C1 and C2. C3 code is stored in an extra frame at the end of the twenty-two frames of data in each group.

changer A mechanism within an autoloader for moving tape cartridges from the magazine into the tape drive, and back again. *See also* **random mode**, **stacker mode**

checksum The sum of a series of bytes written to the tape, which can be checked against the sum of the same series of bytes when the tape is read.

compression A procedure in which data is transformed by the removal of redundant information in order to reduce the number of bits required to represent the data. This is done by representing strings of bytes with codewords.

DAT Digital Audio Tape

data randomizer *see* **randomizing**

data transfer phase On a SCSI bus, devices put in requests to be able to transfer information. Once a device is granted its request, it and the target to which it wants to send information can transfer the data using one of three protocols (assuming both devices support them): asynchronous, synchronous, and wide.
In *asynchronous* transfers, the target controls the flow of data. The initiator can only send data when the target has acknowledged receipt of the previous packet. All SCSI devices must support asynchronous transfer.
In *synchronous* data transfer, the initiator and target work in synchronization, allowing transmission of a packet of data to start before acknowledgment of the previous transmission.
In *wide* data transfer, two bytes are transferred at the same time instead of a single byte.
HP DDS drives support asynchronous, synchronous and 8-bit wide transfers.

DCLZ Data Compression Lempel-Ziv. A compression algorithm based on the Lempel-Ziv LZ2/LZW algorithms, but with improved performance.

DDS Digital Data Storage is a recording format that builds on the DAT format to support the storage of computer data. It was developed originally by Hewlett-Packard and Sony as an industry standard. The first generation standard was DDS-1 (or simply DDS), to which was added data compression to produce the DDS-DC standard.
Further enhancements, notably narrower tracks and thinner tape, led to DDS-2, which can typically provide double the capacity of DDS-1.
DDS-3 uses a new magnetic coating on the tape that allows twice the recording density. Together with the use of time-tracking, this gives a DDS-3 tape approximately three times the capacity of a DDS-2 tape.
DDS-4 uses longer tapes (150m). HP's DDS-4 drives, which are ultra-wide SCSI devices, allow transfer rates from 3 to 4 times greater than DDS-3 and capacities that are two-thirds as much again.

differential *see* **SCSI**

ECC Error Correction Code. *See* **C3 ECC**

ECMA European Computer Manufacturers Association

EOD End Of Data. The end of valid data in a partition on a tape.

fast-searching The process of reading just the Sub-Code areas to locate an item on the tape at a speed significantly faster (90 to 175 times) than normal read speed.

filemark A mark written by the host. It does not necessarily separate files. It is up to the host to assign a meaning to the mark.

forced ejection In an emergency, you can force the drive to eject a cartridge. In doing so, data will probably be lost, and the tape may become unusable, so *be very cautious about using this emergency procedure*. To force the ejection of a cartridge, press the Unload button (the Eject button on the HP C1553A) three times within a 5-minute period, or hold it down for at least 5 seconds.

FRU Field Replaceable Unit, an assembly or group of components that is replaced in its entirety by Service Engineers when it contains a fault.

host The host computer system acting as controller for the drive.

load The process in which the drive takes in an inserted cartridge and goes online.

LVD Low-Voltage Differential. *See* **SCSI**.

magazine A holder for up to six tape cartridges used in autoloaders.

Media Recognition System (MRS) A method by which a drive can recognize data-grade tape. The tape has a series of stripes on its transparent leader tape that the drive can detect. By default, the drive treats a non-Media Recognition System tape as read-only and will not write data to it. However, it is possible to switch the recognition system off using the Configuration switches on the underside of the drive. If this is done, the drive will treat all DDS tapes the same.

N-group writing Sometimes called multiple group writing, N-group writing repeats each group of data so that there are N consecutive copies of each group on the tape. This is a simple way of improving data integrity, but speed and capacity are sacrificed through writing all data several times. N-group writing is not implemented on DDS-3 and DDS-4 drives.

offline The drive is offline if the tape is currently unloaded or not in the drive. The host has limited access, and cannot perform any commands that would cause tape motion. The host can, however, load a tape if one is inserted, and can execute any diagnostic tests that do not require tape motion.

online The drive is online when a tape is loaded. The host has access to all command operations, including those that access the tape, set configurations and run diagnostic tests.

partition A part of a tape that can be treated as a complete and independent whole. A tape can have one or two partitions.

PRML Partial Response Maximum Likelihood—a method of recovering data from a signal that can cope with the higher density of data used by the DDS-3 format (a linear density of 122,000 bits per inch, which is twice that of DDS-1 and DDS-2). The technique not only identifies data bits more accurately, but by scanning the bits surrounding a bit being read, it can deduce the correct value for dubious bits.

random mode *Autoloaders only:* In Random mode, cartridges are used in order dictated by the host or the user, rather than sequentially, as in Stacker mode. For each cartridge to be used, the host must issue a SCSI MOVE MEDIUM command to instruct the autoloader to move the cartridge from the magazine to the drive. When the cartridge is full, or when no further use is to be made of it, the host must again use the MOVE MEDIUM command to load another.
Random mode is sometimes referred to as Changer mode.

randomizing A recoding of data symbols before they are written to tape in order to provide a consistently high RF envelope level. An inconsistent RF envelope is one of the criteria for rewriting a frame on read-after-write.

read-after-write (RAW) Read-after-write improves data integrity by reading data immediately after it is written and writing the frame again if an error is found. The Audio DAT two-head drum is replaced by a four-head drum for this, with two read-only heads and two write-only heads. Frames are only re-written as necessary, so speed and capacity are affected minimally. RAW is included in the DDS format.

SCSI Small Computer System Interface—a standard command specification and command set that enables computers and peripherals to communicate with each other. HP's current family of tape drives adhere to the SCSI-2 specification.

Single-Ended and Low Voltage Differential SCSI

These terms define how the signals are transmitted along the cable.

With *single-ended* (SE) SCSI, each signal travels over a single wire and each signal's value is determined by comparing the signal to a paired ground wire. Signal quality tends to decrease over longer cable lengths or at increased signal speed.

With *low voltage differential* (LVD) signaling, signals travel along two wires and the difference in voltage between the wire pairs determines the signal value. This enables faster data rates and longer cabling with less susceptibility to noise than SE signaling and reduced power consumption.

Narrow and Wide, Fast, Ultra and Ultra2 SCSI

❏ **Narrow** SCSI devices can transfer data one byte at-a-time (and are sometimes called "8-bit SCSI" devices). They can conform to either the SCSI-2 or SCSI-3 protocols. They have a 50-pin connection to the SCSI bus.

❏ **Wide** SCSI devices can transfer two bytes of data simultaneously ("16-bit SCSI"). They usually have a single, 68-pin connection to the SCSI bus. (This physical arrangement is part of the SCSI-3 specification.) They may support either SCSI-2 or SCSI-3 protocols. Wide and narrow devices can simultaneously be connected to the same bus without problem, provided certain rules are followed.

❏ **Fast** SCSI can transfer data at up to 10 MB/sec, using a cable of up to 6 meters total length.

❏ **Ultra** SCSI can transfer data at up to 20 MB/sec, but the cable length cannot exceed 3 meters (it is also known as "Fast20").

❏ **Ultra2** SCSI can transfer data at up to 40 MB/sec, using a cable of up to 25 meters total length for a single device, or up to 12 meters for two or more devices (it is also known as "Fast40").

Ultra SCSI supports both SE and LVD interfaces. Ultra2 SCSI supports LVD interfaces only.

In normal situations, slower devices can coexist with faster devices, and narrow devices can be used on the same SCSI bus as wide devices using a suitable adapter.

HP's DDS-4 drives (HP C5683A and HP C5713A) are ultra-wide SCSI-2 compatible devices. They can be used with both LVD and SE host bus adapters.

sense data Data returned after the execution of a SCSI command, telling the host whether the transaction was successful, and if not, what went wrong.

sequential access Sequential Access devices store data sequentially in the order in which it is received. Tape devices are the most common sequential access devices. Devices such as disk drives are Direct Access devices, where data is stored in blocks, not necessarily sequentially. Direct Access allows for speed of retrieval, but at a price.

setmark A special recorded element within a partition to which the drive can fast-search without having to know the number of records or filemarks that precede the setmark.

single-ended *see* **SCSI**

stabilizing Leaving a cartridge for a period of time in the room in which it is to be used in order to avoid condensation problems caused by changes in humidity and temperature. A period of two hours is recommended.

stacker mode *Autoloaders only:* In Stacker mode, cartridges are used sequentially from the autoloader magazine. The cartridge selected by the user (by pressing the front panel Select button, and then loaded by pressing the Load button) is used first. When it is full, the changer mechanism automatically moves it back to the magazine, and then moves the cartridge in the next highest numbered slot to the drive. This continues until all the cartridges have been used. To load cartridges under host control, the device must be in Random mode.
Stacker mode is sometimes referred to as Sequential mode.

synchronous *see* **data transfer**

system area A section in the Lead-in Area at the beginning of a partition used to store the tape usage information.

Tape log The Tape log contains details of the history of a tape, the total number of groups written, of RAW retries, of groups read, of C3 ECC retries, and of loads. The log is copied into RAM when the tape is loaded into the drive, updated as the tape is used, and loaded back into the System area on the tape when it is unloaded.
Note: For HP C1534A/36A drives firmware version T503, the Tape log is neither loaded from tape nor copied back when the tape is unloaded.

Tape Alert The TapeAlert log holds a set of flags that indicate faults with the drive or tape. For example, the Not Data Grade flag is set to indicate that the drive has detected that a tape that is not Media Recognition System is loaded. By reading this log, host software or the operating system can inform users of existing or impending conditions and can give advice. For example, the software might recommend that you use a new tape or clean the heads.

termination A SCSI bus (or cable) can have many devices plugged into it, but the end of the cable furthest from the host computer must always be *terminated* to avoid signals being reflected back and interfering with other signals. The terminator both absorbs signals and provides power to the lines in the cable. For this reason, it must itself be provided with power.
- ❏ The HP C1534A/36A are permanently configured to provide such power.
- ❏ The other drives can be configured to provide power by setting a jumper on the rear panel—see Figure 2-6.

Terminators can be of two types, active and passive. Active termination is recommended for a bus that has the tape drive on it, because although more expensive, it ensures better and more secure performance.

time-tracking A technique of ensuring that the read head stays in the center of the track that it is reading. The drive measures the time it takes to reach a particular point on the track, and if this time is less than or greater than its expected value, the drive adjusts the tape speed to compensate. In HP's DDS-3 and DDS-4 drives, time-tracking replaces the Automatic Track Following (ATF) used in DDS-1 and DDS-2 drives, and allows more of each track to be available for data storage. DDS-3 and DDS-4 drives still write ATF signals on DDS-1 and DDS-2 tapes to ensure full backward compatibility.

transfer rate The rate at which data is transferred from one device to another, for example from the host computer to the tape drive during backup.

vendor-unique The addition of commands to SCSI that are not included in the standard.

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