

HP Ultrium drives  
Technical reference manual  
Generation 3 drives  
Volume 4: Specifications

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## Revision History

Version	Date	Changed Pages
Edition 5	Dec 2004	For Ultrium Generation 3 SCSI and FC drives only

This document is frequently revised and updated. To find out if there is a later version, please ask your HP OEM Representative.

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# Related documents

The following documents provide additional information:

## Documents specific to HP Ultrium drives

- Hardware Integration Guide, volume 2 of the HP Ultrium Technical Reference Manual
- Software Integration Guide, volume 2 of the HP Ultrium Technical Reference Manual
- The SCSI Interface, volume 3 of the HP Ultrium Technical Reference Manual
- HP Ultrium Configuration Guide, volume 5 of the HP Ultrium Technical Reference Manual
- Background to Ultrium Drives, volume 6 of the HP Ultrium Technical Reference Manual
- HP Ultrium Technology White Paper, describing features and benefits of HP Ultrium drives

Please contact your HP supplier for copies.

## Documentation map

The following will help you locate information in the 6-volume Technical Reference Manual:

### Drives—general

	SCSI Drives	FC Drives
Connectors	1 HW Integration: <i>ch. 7</i>	1 HW Integration: <i>ch. 4</i>
Controller architecture	6 Background: <i>ch. 4</i>	
Front Panel LEDs	1 HW Integration: <i>ch. 6</i>	1 HW Integration: <i>ch. 3</i>
Mechanism and hardware	6 Background: <i>ch. 3</i>	
Specifications	4 Specs	

### Installation and configuration

	SCSI Drives	FC Drives
Connectors	1 HW Integration: <i>ch. 7</i>	1 HW Integration: <i>ch. 4</i>
Determining the configuration	2 SW Integration: <i>ch. 2</i>	2 SW Integration: <i>ch. 2</i>
External drives ( <i>SCSI only</i> )	1 HW Integration: <i>ch. 5</i>	n/a
In Libraries	1 HW Integration: <i>ch. 1</i>	
In Servers ( <i>SCSI only</i> )	1 HW Integration: <i>ch. 4</i>	n/a
In Tape Arrays ( <i>SCSI only</i> )	1 HW Integration: <i>ch. 3</i>	n/a
Modes of Usage ( <i>SCSI only</i> )	1 HW Integration: <i>ch. 8</i>	n/a
Optimizing performance ( <i>SCSI only</i> )	1 HW Integration: <i>ch. 8</i>	n/a
	2 SW Integration: <i>ch. 4</i>	
UNIX configuration	5 UNIX Config	

## Operation

	SCSI Drives	FC Drives
External drives ( <i>SCSI only</i> )	1 HW Integration: <i>ch. 5</i>	n/a
In Libraries	1 HW Integration: <i>ch. 1</i>	
In Servers ( <i>SCSI only</i> )	1 HW Integration: <i>ch. 4</i>	n/a
In Tape Arrays ( <i>SCSI only</i> )	1 HW Integration: <i>ch. 3</i>	n/a

## Cartridges

	SCSI Drives	FC Drives
Cartridge Memory (LTO-CM)	2 SW Integration: <i>ch. 5</i> 6 HW Integration: <i>ch. 5</i>	
Cartridges	1 HW Integration: <i>ch. 9</i>	1 HW Integration: <i>ch. 5</i>
Features	6 HW Integration: <i>ch. 5</i>	
Managing the use of cartridges	2 SW Integration: <i>ch. 1</i>	
Use of cartridges	2 SW Integration: <i>ch. 3</i>	

## Interface

	SCSI Drives	FC Drives
SCSI Guide	3 SCSI	
Commands	3 SCSI: <i>ch. 4</i>	
Error codes	1 HW Integration: <i>ch. 10</i>	1 HW Integration: <i>ch. 6</i>
Implementation	3 SCSI: <i>ch. 1</i>	
Interpreting sense data	2 SW Integration: <i>ch. 3</i>	
Messages	3 SCSI: <i>ch. 2</i>	
Mode pages —see the MODE SENSE command	3 SCSI: <i>ch. 4</i>	
Pre-execution checks	3 SCSI: <i>ch. 3</i>	
Responding to Sense Keys and ASC/Q	2 SW Integration: <i>ch. 6</i>	
Sense Keys and ASC/Q —see REQUEST SENSE command	3 SCSI: <i>ch. 4</i>	

## Maintenance and troubleshooting

	SCSI Drives	FC Drives
Cleaning	2 SW Integration: <i>ch. 5</i> 2 SW Integration: <i>ch. 7</i>	
External drives ( <i>SCSI only</i> )	1 HW Integration: <i>ch. 5</i>	n/a
In Libraries	1 HW Integration: <i>ch. 1</i>	
In Servers ( <i>SCSI only</i> )	1 HW Integration: <i>ch. 4</i>	n/a
In Tape Arrays ( <i>SCSI only</i> )	1 HW Integration: <i>ch. 3</i>	n/a

	SCSI Drives	FC Drives
Monitoring drive and tape condition	2 SW Integration: <i>ch. 7</i>	
Software troubleshooting techniques	2 SW Integration: <i>ch. 1</i>	

## Dealing with errors

	SCSI Drives	FC Drives
Error Codes	1 HW Integration: <i>ch. 10</i>	1 HW Integration: <i>ch. 6</i>
Handling errors	2 SW Integration: <i>ch. 5</i>	
How error correction works	6 Background: <i>ch. 4</i>	
Logs—see the LOG SENSE command	3 SCSI: <i>ch. 4</i>	
Recovering from write and read errors	2 SW Integration: <i>ch. 7</i>	
Software response to error correction	2 SW Integration: <i>ch. 3</i>	
Software response to logs	2 SW Integration: <i>ch. 3</i>	
TapeAlert log	2 SW Integration: <i>ch. 7</i>	

## Ultrium features

	SCSI Drives	FC Drives
Adaptive Tape Speed (ATS)	6 Background: <i>ch. 1</i>	
Autoload	1 HW Integration: <i>ch. 2</i>	
Automation Control Interface (ACI)	1 HW Integration: <i>ch. 2</i> 6 Background: <i>ch. 1</i>	
Cartridge Memory (LTO-CM)s	1 HW Integration: <i>ch. 2</i> 2 SW Integration: <i>ch. 5</i> 6 HW Integration: <i>ch. 5</i>	
Data Compression, how it works	6 Background: <i>ch. 5</i>	
Data Compression, managing	2 SW Integration: <i>ch. 5</i>	
Design principles	6 Background: <i>ch. 1</i>	
OBDR and CD-ROM emulation	6 Background: <i>ch. 1</i> 2 SW Integration: <i>ch. 7</i>	
Performance optimization	1 HW Integration: <i>ch. 8</i>	n/a
	2 SW Integration: <i>ch. 1</i>	
Performance, factors affecting	2 SW Integration: <i>ch. 4</i>	
Software design	2 SW Integration: <i>ch. 1</i>	
Supporting Ultrium features	2 SW Integration: <i>ch. 5</i>	
Ultrium Format	6 Background: <i>ch. 2</i>	

## General documents and standardization

- Enhanced Small Computer System Interface (SCSI-2), ANSI X3T9.2-1993 Rev. 10L, available through ANSI

- See [http://www.t10.org/t10\\_main.htm](http://www.t10.org/t10_main.htm) for ANSI SCSI-3 and other specifications

Copies of documents of other standards bodies 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



# 1 Features

Feature	Specification
Recording format	Linear Tape Open Ultrium-3 and Ultrium-2. Ultrium-1 tapes can be read but not written.
Data compression	ALDC
Data encoding method	16-channel PRML
Variable speed recording	27–80 MB/s (1:3) Ultrium-3
Read-While-Write	Standard—data is verified immediately after it is written
Auxiliary memory in cartridge (CM)	Standard part of the Ultrium format
Data interfaces	<i>SCSI:</i> Ultra320 SCSI Serial-Attach-SCSI (SAS)  <i>FC:</i> 2 Gb/s Fibre Channel, Class 3, dual port, multi-mode connector: duplex-LC (native)
Library interface	Bi-directional RS422 (serial protocol RS422 9600 to 115200 baud)
Main data buffer size	128 MB
Burst buffer size	<i>SCSI:</i> 8 MB <i>Fibre Channel:</i> 16 MB

# 2 Physical specification

## Dimensions

		SCSI	Fibre Channel
Internal	<i>width:</i>	146 mm (5.75")	146 mm (5.75")
	<i>height:</i>	82.5 mm (3.25")	82.5 mm (3.25")
	<i>depth:</i>	203 mm (8")	213.8 mm (8.4")
External	<i>width:</i>	208 mm (8.2")	n/a
	<i>height:</i>	121 mm (4.75")	n/a
	<i>depth:</i>	298 mm (11.75")	n/a
Rack-Mount	<i>width:</i>	208 mm (8.2")	n/a
	<i>height:</i>	121 mm (4.75")	n/a
	<i>depth:</i>	298 mm (11.7")	n/a

## Detailed dimensions

Figure 1-1 Plan

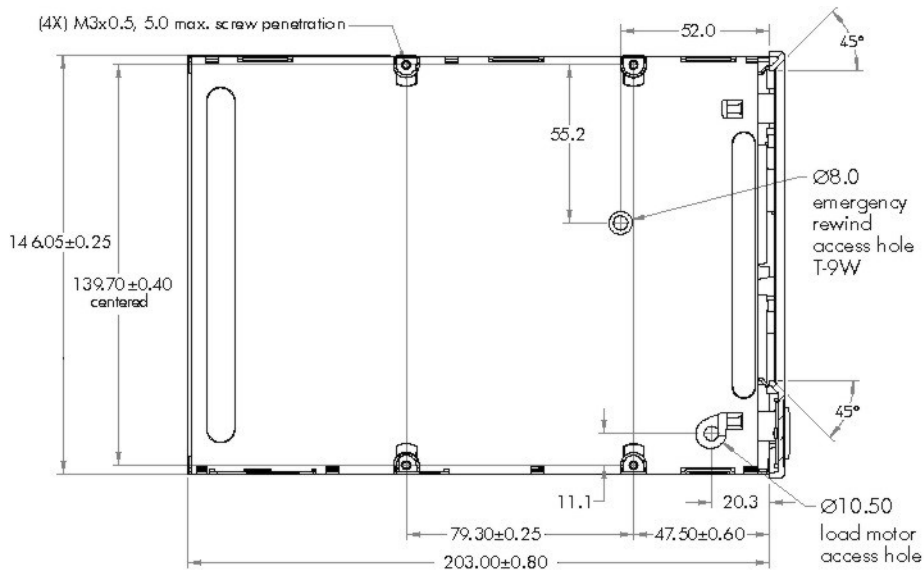
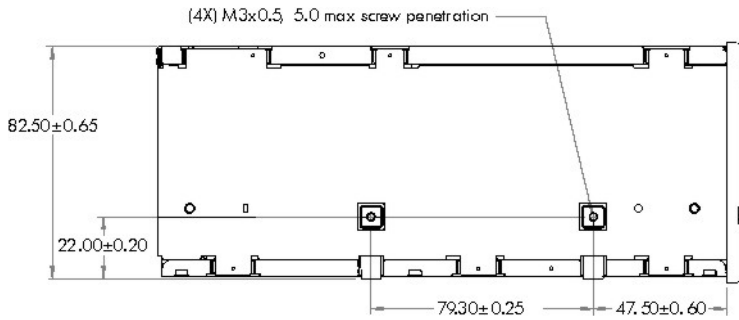


Figure 1-2 Side



With Fiber Channel, the connector stands out at the back of the drive:

Figure 1-3 Fibre Channel connector

*[No drawing available as of November 30, 2004]*

Figure 1-4 Front

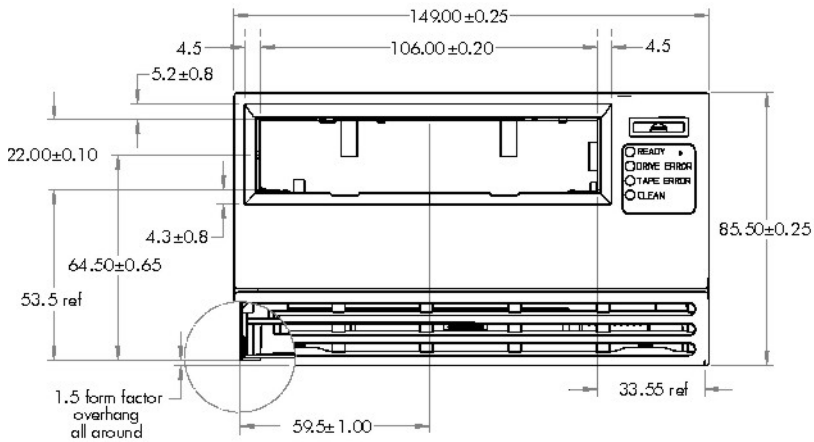


Figure 1-5 Rear View—SCSI

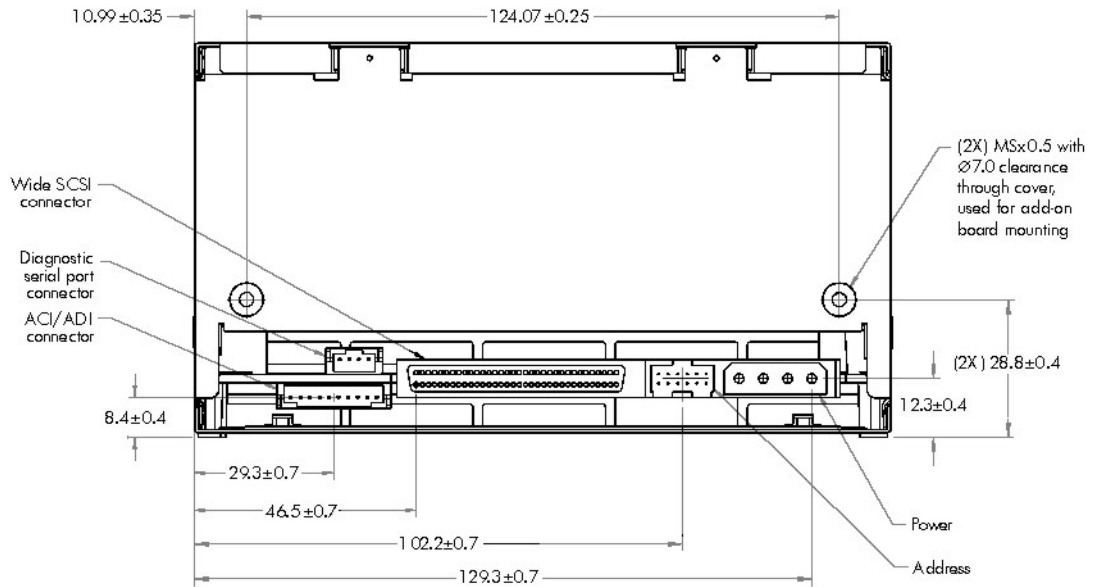


Figure 1-6 Rear view—Fibre Channel

*[No drawing available as of November 30, 2004]*

## Product weight

*Internal\** 2.239 kg (4.94 lb)

*External* 5.572 kg (12.28 lb)

\*including front panel and ESD bag but excluding rails

## Drive orientation

An HP Ultrium drive will operate in the 0°, -90° and +90° when viewed from the front panel. In addition, in the 0° axis, the drive will operate with +20° nose-up tilt.

# 3 Electrical requirements

## PSU requirements

### Internal and rack-mounted drives

The drives are specified to operate at 5V±5% and 12V±10%. Any PSU used to power the drive must be capable of providing 5V nominal (when the drive pulls 5A on the 5V rail) and 12V nominal (when the drive pulls 2A on the 12V rail). HP recommends a 10% buffer when selecting a power supply source capable of delivering the amperage and power required.

Specification	SCSI Drives		FC Drives	
	5V	12V	5V	12V
Maximum voltage	5.25V	13.2V	5.25V	13.2V
Minimum voltage	4.75V	10.8V	4.75V	10.8V
Maximum steady-state current	4.75*A	1.0A	4.75*A	1.0A
Maximum transient current	4.75*A	2.0A	4.75*A	2.0A
Maximum steady-state power	22.5W	12W	17.5W	12W
Maximum transient power	22.5W	24W	22.5W	24W
Maximum noise/ripple	150 mVpp	150 mVpp	150 mVpp	150 mVpp

\* The current values are calculated based on constant power and minimum power supply voltage.

## Power consumption

	Internal Drives	External Drives
Power Requirements	<40W	100–240 VAC 50/60 Hz 0.8A max.
<i>5V DC</i>	3.0A typical (4.5A max.)	
<i>12V DC</i>	0.8A typical (2.0A max.)	

Activity	SCSI Drives		FC Drives
	Average	Peak	Average
Idle	15.8W	15.8W	TBD
Load	18.1W	32.3W	TBD
Write	30.2W	35.3W	TBD

Activity	SCSI Drives		FC Drives
	Average	Peak	Average
Read	24.3W	30.8W	TBD
Reposition/Rewind	24.4W	31.6W	TBD
Unload	16.8W	28.2W	TBD

# 4 Electromagnetic compatibility

NOTE: The EMC performance of internal storage products depends on the characteristics of the system in which the product is installed. HP has tested products installed in network storage system enclosures and in external desktop enclosures to verify EMC performance against the regulatory standards in force at the time of introduction.

## ITE emissions

Parameter	Standards	
	International	European Economic Area
Radiated and conducted	CISPR 22:1997 + Amendment 1:2000 + Amendment 2:2002 FCC CFR 47 Part 15, referencing ANSI C63.4-2003 (U.S.A. only)	EN 55022:1998 + /A1:2000 + /A2:2003
Harmonic current	IEC 61000-3-2:2000	EN 61000-3-2:2000
Voltage fluctuations and flicker	IEC 61000-3-3:1994 + Amendment 1:2001	EN 61000-3-3:1995 + /A1:2001

## ITE immunities

Parameter	Standards	
	International	European Economic Area
Generally	CISPR 24:1997 + Amendment 1:2001 + Amendment 2:2002 <i>referencing the following:</i>	EN 55024:1998 + /A1:2001 + /A2:2003 <i>referencing the following:</i>
Electrostatic discharge	IEC 61000-4-2:1995	EN 61000-4-2:1995
Radiated RF electromagnetic field	IEC 61000-4-3:1995	EN 61000-4-3:1996
Electrical fast transient/Burst	IEC 61000-4-4:1995	EN 61000-4-4:1995
Surge	IEC 61000-4-5:1995	EN 61000-4-5:1995
Conducted disturbances by RF fields	IEC 61000-4-6:1996	EN 61000-4-6:1996
Power frequency magnetic field	IEC 61000-4-8:1993	EN 61000-4-8:1993
Voltage dips, interruptions & variations	IEC 61000-4-11:1994	EN 61000-4-11:1994

## DC magnetic field interference

- IATA Dangerous Goods Regulations, 30th Edition, 1989-01-01
- U.S. CFR 49, paragraph 173.1020, revision date: 1983-11-01



# 5 Environmental

## Climatics

These apply to the mechanism unless otherwise noted. For the environmental specification of media, see Chapter 7, "Media".

### Operating

Parameter	Specification
Operating temperature with media	<i>at 6 cfm airflow:</i> 10°C to 35°C (50°F to 95°F) <i>at 8 cfm airflow:</i> 10°C to 40°C (50°F to 104°F)
Maximum operating temperature rise	10°C/hr (50°F/hr)
Operating non-condensing humidity	20% to 80% RH
Maximum operating humidity rise	<30%/hr
Maximum wet bulb temperature	26°C (79°F)
Operating altitude	0 to 4 km (0 to 13,000 ft)

### Non-operating

Parameter	Specification
Non-operating temperature	-40°C to 66°C (-40°F to 151°F)
Maximum non-operating temperature rise	20°C/hr (68°F/hr)
Non-operating humidity	10% to 95% RH
Non-operating humidity rise	30%/hr
Non-operating altitude	0 to 15.25 km (0 to 50,000 ft)

### General

Parameter	Specification
Suspended particle density	<200 µg/m <sup>3</sup>

## Dynamics

Parameter	Specification
Operating sine vibration	0.31G pk 5–500 Hz @ 1 octave/min with 15 min dwell at peak resonance
Operating random vibration	0.31G rms 5–500 Hz $0.000194 \text{ g}^2/\text{Hz}$
Operating shock	5G 3 ms half-sine (no performance change) 2G 11 ms half-sine (no performance change) 8G 11 ms half-sine (no data loss) Pulse rate: 0.1 Hz
Non-operating sine vibration	1.0G pk 5–500 Hz @ 1 octave/min with 5 min dwell at peak resonance
Non-operating random vibration	2.41G rms 5–500 Hz
Non-operating shock	90G 3 ms half-sine (no damage) 30G 26 ms trapezoidal (no damage)
Transportation sine vibration	0.5G pk 5–200–5 Hz @ 1 octave/min with 5 min dwell at peak resonance
Transportation random vibration	1.47G rms 5–200 Hz
Package drop	0.91m (36 in)

## Noise

Parameter	Specification
Operating acoustic noise	<5.0 bel sound power

## Airflow

HP Ultrium drives require forced airflow from front to back.

Parameter	Specification
Airflow (operating and non-operating)	0.17 m <sup>3</sup> /min (6 cu ft/min) at 35°C ambient operation, rising to 0.23 m <sup>3</sup> /min (8 cu ft/min) for up to 40°C ambient operation

# 6 Safety

## Safety regulatory standards

Agency	Referenced Standard
Underwriters Laboratories (UL)	UL 60951 First Edition
Canadian Standards Association (CSA)	CSA 22.2 60950-1-03
CE and TÜV	EN 60950-1:2001, including all amendments IEC 60950-1:2001, including all amendments
CB Report and Certificate	IEC 60950-1:2001, including all amendments (including all National Deviations)

## Required agency approvals

Agency	National Standard
NOM-1-NYCE	Product Safety: NOM-0190SCFI-1998
GOSH	Product Safety: GOST R 50377 EMC: GOST R 51318.22-99 & GOST R 50839=2000 Acoustic Report: GOST 26329-84
VCCI	EMC: CISPR 22:1997
C-Tick	EMC: AS/NZS 3548 (EN 55022, CISPR22)
RRL	MIC No. 1996-18 (EN 55022)
BSMI	CNS 13438

## Transceivers

The Fibre Optic transceivers used in FC products are Class 1 Laser components and comply with US FDA regulations.

These components are certified to meet the Class 1 eye safety requirements of EN (IEC) 60825 and the electrical safety requirements of EN (IEC) 60950.

# 7 Media

## Specification

HP Product Number	Format	Capacity*	Notes
C7973A	U3	800 GB	Read and write
C7973W	U3 WORM	800 GB	Write once, read many times
C7972A	U2	400 GB	Read and write
C7971A	U1	200 GB	Read-only in Gen 3 drives

\*Capacities at 2:1 data compression. The actual capacity depends on the compression ratio of the data. This is typically 2:1 but can be anywhere between 1:1 and 110:1.

		Ultrium 1	Ultrium 2	Ultrium 3
Tape	<i>Base film:</i>	6 µm (Poly-Ethylene-Naphthalate) PEN		
	<i>Tape length:</i>	609m	609m	680m
	<i>Tape length used for data:</i>	580m	580m	648m
	<i>Tape width:</i>	12.65 mm	12.65 mm	12.65 mm
	<i>Tape thickness:</i>	8.9±0.3 µm	8.9±0.3 µm	8.0±0.3 µm
	<i>Tape dimensional stability:</i>	1200 ppm	1200 ppm	1200 ppm
	<i>Maximum tape speed:</i>	5.5 m/s	7.29 m/s	7.29 m/s
	<i>Rewind speed:</i>	4.1 m/s	7.00 m/s	7.00 m/s
	<i>Durability:</i>	1,000,000 passes	1,000,000 passes	1,000,000 passes
	Cartridge	<i>Width:</i>	105.4±0.30 mm	105.4±0.30 mm
<i>Depth:</i>		102.0±0.30 mm	102.0±0.30 mm	102.0±0.30 mm
<i>Height:</i>		21.5±0.25 mm	21.5±0.25 mm	21.5±0.25 mm
<i>Weight:</i>		0.220 kg	0.220 kg	0.220 kg
Recording layout	<i>Track pitch:</i>	27.5 µm	20.17 µm	14.3 µm
	<i>Track density (TPI):</i>	768	1024	1773
	<i>Data tracks:</i>	384	512	704
	<i>Data channels:</i>	8	8	16
	<i>Number of wraps:</i>	48	64	44
	<i>Number of bands:</i>	4	4	4
	<i>Bit density:</i>	4.88 kb/mm	7.32 kb/mm	9.57 kb/mm

## Environmental specifications (media)

### Operating

Parameter	Specification
Ambient Temperature	10°C to 45°C (50°F to 113°F)
Relative Humidity (non-condensing)	10% to 80%
Maximum Wet Bulb Temperature	26°C (78.8°F)

### Storage (day-to-day)

Parameter	Specification
Ambient Temperature	16°C to 35°C (60°F to 95°F)
Relative Humidity (non-condensing)	20% to 80%
Maximum Wet Bulb Temperature	26°C (78.8°F)

### Storage (transportation)

Parameter	Specification
Ambient Temperature	-23°C to 49°C (-9.4°F to 102°F)
Relative Humidity (non-condensing)	5% to 80%
Maximum Wet Bulb Temperature	26°C (78.8°F)

### Storage (archival)

Cartridges should be stored in plastic containers, preferably on their sides.

Parameter	Specification
Ambient Temperature	16°C to 25°C (60°F to 77°F)
Relative Humidity (non-condensing)	10% to 50%
Maximum Wet Bulb Temperature	26°C (78.8°F)
Archive Life	30 years

## LTO-Cartridge Memory (EEPROM)

LTO Cartridge Memory (LTO-CM) is EEPROM memory that is embedded in every LTO Ultrium tape cartridge. It is non-volatile and is contactless in that it is read by RF coupling rather than electrical contact.

## Interface specification

- Contactless, passive RF interface using a proximity inductive coupling with a range in the order of millimeters.
- Power to the transponder is coupled through the interface.
- The range depends on implementation (10 to 20 mm is the maximum). The best error rate performance will occur at short distances.
- The memory can be read from below (by a drive) or from the front (in libraries).
- 32 kilobits (4 kilobytes)
- Organized as 128 x 32 byte blocks
- >500K write cycles, 20 year data retention life
- Write size is word wide (2 bytes) or block wide (32 bytes)
- The transfer-rate performance of the cartridge memory is as follows:
  - *Reads:* 2 byte: ~20 Kb/s 32 byte: ~70 Kb/s 4 KB: ~0.5s
  - *Writes:* 2 byte: ~1.4 Kb/s 32 byte: ~18.5 Kb/s 4 KB: ~1.8s
  - 32 byte read: ~ 5.8 ms 32 byte write: ~ 15.8 ms

## Further information

- For general information about LTO-CM, see “LTO Cartridge Memory” in Chapter 5, “Cartridges” in Background to Ultrium Drives, Volume 6 of the Ultrium Technical Manual.
- For suggestions of how to make use of cartridge memory in libraries, see “LTO Cartridge Memory (LTO-CM)” in Chapter 5, “Supporting Ultrium Features” in Software Integration, Volume 2 of the Ultrium Technical Manual.

# 8 Ultrium format standard

## Compatibility

HP Gen 3 Ultrium drives are specified to interchange data cartridges with other tape drives that comply to the LTO U-18, U-28, and U-316 specification documents:

Capacity (2:1 compression)	Format	Write	Read
800 GB WORM	Ultrium-3	Yes	Yes
800 GB (680m)	Ultrium-3	Yes	Yes
400 GB (580m)	Ultrium-2	Yes	Yes
200 GB (580m)	Ultrium-1	No	Yes
100 GB (290m)	Ultrium-1	No	Yes

This specification is only applicable when:

- Cartridges carry the Ultrium logo.
- Cartridges are not damaged or faulty.
- Cartridges are read on a drive in good operating condition, and have been written on a logo-certified drive that is in good condition.
- The environmental conditions (including DC voltage supplies) are within the specified limits.

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NOTE: HP Gen 3 Ultrium drives do not support 10 GB and 30 GB cartridges. HP recommends the use of the SET CAPACITY SCSI command to shorten standard cartridges logically for test purposes.

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## Future compatibility

In future, HP Ultrium drives will always be capable of reading and writing tapes from the current generation and one generation before, and reading tapes from two generations before. HP Ultrium drives will always maintain write and read compatibility with other manufacturers' Ultrium drives and tapes that meet the LTO Ultrium format specification.

# 9 Reliability

Description	Specification
MTBF (100% duty cycle)	250,000 hours
Load/unload life	100,000 swaps
MSBF (automation swaps)	100,000 swaps
Head life (typical)	60,000 hours
Media durability	1,000,000 passes
Maximum cartridge uses	20,000 threads
Backup failure rate	<0.1%
Restore failure rate	<0.001%
Interchange failure rate	<0.1%
Uncorrectable error rate	1 in $10^{17}$ bits
Undetected error rate	1 in $10^{27}$ bits
Tape pulling life (5 years at 100% duty cycle)	43,800 hours



# 10 Performance specification

## Transfer rates

		SCSI	FC
Sustained transfer rate	<i>Native:</i>	80 MB/s	80 MB/s
	<i>Compressed (2:1):</i>	160 MB/s	160 MB/s
Burst transfer rate	<i>Ultra3 SCSI wide:</i>	320 MB/s	
	<i>Ultra3 FC:</i>		2 GB/s: class 3
ATS data rate range (3:1)		27–80 MB/s (U3)	
		10–30 MB/s (U2)	
		6.6–20 MB/s (U1)	

The bandwidth of the data compression engine determines the drive's streaming capabilities based on the compression ratio of the data it is handling as follows:

<i>Compression Engine Bandwidth:</i>	120 MB/s
<i>Maximum Streaming Compression Ratio:</i>	3:1

The drive will match the throughput of any host up to the maximum native transfer rate multiplied by the current compression ratio. There will not be any performance penalty for hosts that are slower than the maximum. This capability is accomplished with a 64 MB buffer and the Adaptive Tape Speed (ATS) algorithm.

## Data compression

The compression engine uses an enhanced algorithm based on ALDC where data expansion due to redundant data is minimized to <5%. This is achieved by having two compression schemes (normal and pass-through) with the ability to switch dynamically between them.

It is possible to force the drive to use Scheme 2 (pass-through mode) of the LTO-DC algorithm using the Data Compression mode page or the SDCA parameter in the Sequential Access Mode Page.

## Speeds

Maximum tape speed	7.00 m/s
Tape read/write speed	5.32 m/s (Ultrium-3), 5.50 m/s (Ultrium-1/2)
Tape rewind speed	7.00 m/s

# Timings

## Capacity full backup times

The following table shows approximate backup times for the available tape cartridges:

Cartridge	Time
800 GB Ultrium 3	1 hr 30 min at a transfer rate >70 MB/s
400 GB Ultrium 2	1 hr 55 min
200 GB Ultrium 1	1 hr 55 min

## Load/unload times

The load and unload times are as follows:

	SCSI	FC
Typical load time to BOT, ready to read or write	<19s*	<19s*
Unload time, excluding rewind	<19s	<19s
Automation eject (tape unthreaded)	<1s	<1s

\* The unload time for WORM cartridges is greater, typically 22s

## Access times (time to data)

	Time
Average access time from BOT	<i>800 GB Ultrium 3:</i> 52s <i>400 GB Ultrium 2:</i> 46s <i>200 GB Ultrium 1:</i> 46s
Maximum access time from BOT	<i>800 GB Ultrium 1:</i> 104s <i>400 GB Ultrium 2:</i> 92s <i>200 GB Ultrium 1:</i> 92s

## Other times

Parameter	Time
Mean reposition time	2.5s
Turn-around time at end of wrap	1.5s max.
Time to rewind EOT—BOT at 7.0 m/s	98s (U3), 88s (U1/2)
Time to rewind MOT—BOT at 7.0 m/s	49s (U3), 44s (U1/2)
Cleaning time with a cleaning cartridge	<180s

# 11 Automation Control Interface

## Specification

### Physical interface

- RS-422, Drive Sense, Library Sense, Reset and Attention signals
- A default of 9600 baud at power-on, after a tape drive reset and after an ACI reset. After that, the library can configure the tape drive to use other baud rates (19200, 38400, 57600 and 115200 baud for HP Ultrium drives) using the Set Baud Rate command.
- 1 start bit, 8 data bits, 2 stop bits, no parity

### Protocol

- Binary data packets, including checksum, packet length, status, sequence number,
- XON/XOFF flow control
- Positive or negative acknowledgement of transmission
- Constant polling not necessary— the drive returns status upon completion of each command

### ACI command set

The following ACI commands are supported on HP Ultrium drives:

Mandatory Commands	Optional Commands	SCSI Surrogate Commands
00h Get Drive Info	40h Send SCSI Command	70h Configure SCSI Surrogate
01h Load	42h Send Firmware Image	71h Get SCSI CDB
02h Unload	43h Get Firmware Segment	72h Get SCSI Data
03h Get Drive Status	49h Get Buffer Size	73h Send SCSI Data
04h Set Drive Configuration	4Ah Send Firmware Segment	74h Send SCSI Status
05h Get Drive Configuration	4Bh Set Time	
06h Reset	4Ch Get Time	
07h Set Baud Rate		
08h No Op		
09h Get Error Info		
0Ah Acknowledge Attention		



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