

HP LTO Ultrium tape drives  
technical reference manual  
LTO 4 FC, SCSI and SAS drives  
volume 4: specifications

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## Revision history

Version	Date	Changes
Edition 2.1	August 2007	For LTO Ultrium 4 FC, SCSI and SAS drives

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

HP LTO Ultrium 4 drives technical reference manual, volume 4: specifications

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## Related documents

This is one of six volumes that document HP LTO Ultrium drives. This volume gives specifications for the following products. The capacities are using hardware data compression with a compression ratio of 2:1 where applicable:

- HP LTO Ultrium 4 Fibre Channel tape drives
- HP LTO Ultrium 4 SCSI tape drives
- HP LTO Ultrium 4 SAS tape drives

The following documents provide additional information:

### Documents specific to HP LTO Ultrium drives

- *Hardware Integration Guide*, volume 1 of the HP LTO Ultrium Technical Reference Manual
- *Software Integration Guide*, volume 2 of the HP LTO Ultrium Technical Reference Manual
- *Host Interface Guide*, volume 3 of the HP LTO Ultrium Technical Reference Manual
- *UNIX, Linux and OpenVMS Configuration Guide*, volume 5 of the HP LTO Ultrium Technical Reference Manual

Please contact your HP supplier for copies.

- The features and benefits of HP LTO Ultrium drives are discussed in the HP LTO Ultrium Technology White Paper.
- For a general background to LTO technology and licensing, go to <http://www.lto-technology.com>.

## Documentation map

The following will help you locate information in the Technical Reference Manual. A reference like “**1** HW Integration: *ch. 7*” means Volume 1, *Hardware Integration Guide*, of the HP LTO Ultrium Technical Reference Manual, chapter 7.

### Drives—general

	FC Drives	SCSI Drives	SAS Drives
Connectors	<b>1</b> HW Integration: <i>ch. 4</i>	<b>1</b> HW Integration: <i>ch. 7</i>	
Front panel LEDs	<b>1</b> HW Integration: <i>ch. 3</i>	<b>1</b> HW Integration: <i>ch. 6</i>	
Specifications	<b>4</b> Specifications		

### Installation and configuration

	FC Drives	SCSI Drives	SAS Drives
Connectors	<b>1</b> HW Integration: <i>ch. 4</i>	<b>1</b> HW Integration: <i>ch. 7</i>	
Determining the configuration	<b>2</b> SW Integration: <i>ch. 2</i>		
External drives	n/a	<b>1</b> HW Integration: <i>ch. 5</i>	

	FC Drives	SCSI Drives	SAS Drives
In libraries	1 HW Integration: <i>ch. 1</i>		
In servers	n/a	1 HW Integration: <i>ch. 4</i>	
In tape arrays	n/a	1 HW Integration: <i>ch. 3</i>	n/a
Linux configuration	5 UNIX, Linux, OpenVMS Configuration		
Modes of usage	n/a	1 HW Integration: <i>ch. 8</i>	n/a
OpenVMS configuration	5 UNIX, Linux, OpenVMS Configuration		
Optimizing performance	n/a	1 HW Integration: <i>ch. 8</i>	n/a
		2 SW Integration: <i>ch. 4</i>	
UNIX configuration	5 UNIX, Linux, OpenVMS Configuration		

## Operation

	FC Drives	SCSI Drives	SAS Drives
External drives	n/a	1 HW Integration: <i>ch. 5</i>	
In libraries	1 HW Integration: <i>ch. 1</i>		
In servers	n/a	1 HW Integration: <i>ch. 4</i>	
In tape arrays	n/a	1 HW Integration: <i>ch. 3</i>	n/a

## Cartridges

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

## Interface

	FC Drives	SCSI Drives	SAS Drives
FC, SCSI and SAS host interface guide	3 Host Interface		
Commands	3 Host Interface: <i>ch. 5</i>		
Error codes	1 HW Integration: <i>ch. 6</i>	1 HW Integration: <i>ch. 10</i>	
Implementation	3 Host Interface: <i>ch. 1</i>		
Interpreting sense data	2 SW Integration: <i>ch. 3</i>		
Messages	3 Host Interface: <i>ch. 2</i>		
Mode pages —see the MODE SENSE command	3 Host Interface: <i>ch. 5</i>		

	FC Drives	SCSI Drives	SAS Drives
Pre-execution checks		3 Host Interface: <i>ch. 4</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 Host Interface: <i>ch. 5</i>	
Task management functions	n/a	3 Host Interface: <i>ch. 3</i>	

## Maintenance and troubleshooting

	FC Drives	SCSI Drives	SAS Drives
Cleaning		2 SW Integration: <i>ch. 5</i> 2 SW Integration: <i>ch. 7</i>	
External drives	n/a	1 HW Integration: <i>ch. 5</i>	
In libraries		1 HW Integration: <i>ch. 1</i>	
In servers	n/a	1 HW Integration: <i>ch. 4</i>	
In tape arrays)	n/a	1 HW Integration: <i>ch. 3</i>	n/a
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

	FC Drives	SCSI Drives	SAS Drives
Error codes	1 HW Integration: <i>ch. 6</i>	1 HW Integration: <i>ch. 10</i>	
Handling errors		2 SW Integration: <i>ch. 5</i>	
Logs—see the LOG SENSE command		3 Host Interface: <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>	

## LTO Ultrium features

	FC Drives	SCSI Drives	SAS Drives
Autoload		1 HW Integration: <i>ch. 2</i>	
Automation Control Interface (ACI)		1 HW Integration: <i>ch. 2</i>	
Cartridge Memory (LTO-CM)		1 HW Integration: <i>ch. 2</i> 2 SW Integration: <i>ch. 5</i>	
Data compression, managing		2 SW Integration: <i>ch. 5</i>	
OBDR and CD-ROM emulation		2 SW Integration: <i>ch. 7</i>	

	FC Drives	SCSI Drives	SAS Drives
Performance optimization	n/a	1 HW Integration: <i>ch. 8</i>	
		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 LTO Ultrium features		2 SW Integration: <i>ch. 5</i>	

## General documents and standardization

See [http://www.t10.org/t10\\_main.htm](http://www.t10.org/t10_main.htm) for INCITS SCSI Primary Commands—3 (SPC-3), SCSI Streaming Commands (SSC-3) and other specifications

Copies of documents of other standards bodies can be obtained from:

*INCITS* 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

		Specification
<b>Feature</b>	<b>Full-height drives</b>	
<b>Recording format</b>	Linear Tape Open Ultrium-4 and Ultrium-3. LTO Ultrium-2 tapes can be read but not written.	
<b>Data compression</b>	ALDC	
<b>Data encoding method</b>	16-channel PRML	
<b>Variable speed recording</b>	40–120 MB/s LTO 4	
<b>Read-While-Write</b>	Standard—data is verified immediately after it is written	
<b>Auxiliary memory in cartridge (CM)</b>	Standard part of the LTO Ultrium format	
<b>Data interfaces</b>	<i>FC:</i>	4 Gb/s Fibre Channel, Class 3, dual port, multi-mode connector: duplex-LC (native)
	<i>SCSI:</i>	Ultra320 SCSI Wide
	<i>SAS:</i>	3 GB
<b>Library interface</b>	Bi-directional RS422 (serial protocol RS422 9600 to 115200 baud/8 bits)	
<b>Main data buffer size</b>	128 MB	
<b>Burst buffer size</b>	<i>FC:</i>	16 MB
	<i>SCSI, SAS:</i>	8 MB



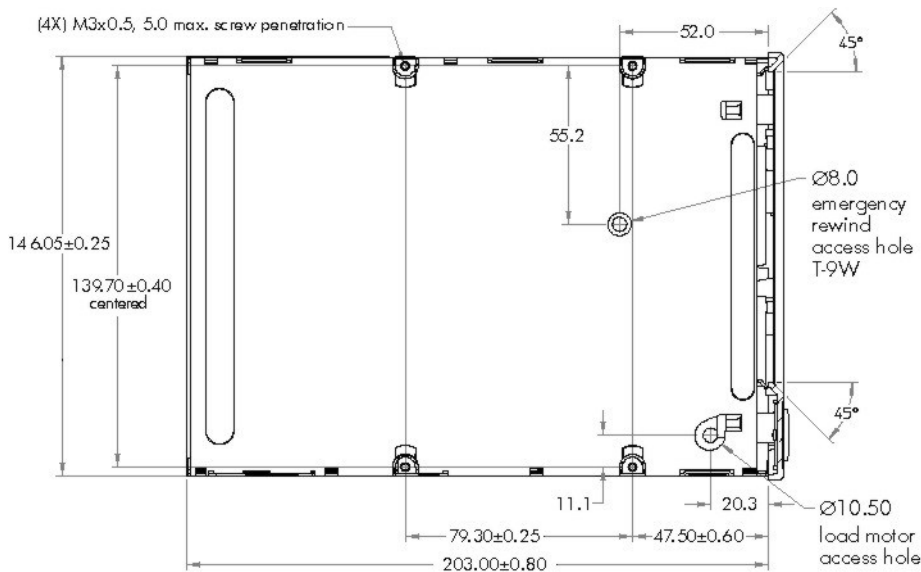
## 2 Physical specification

### Dimensions

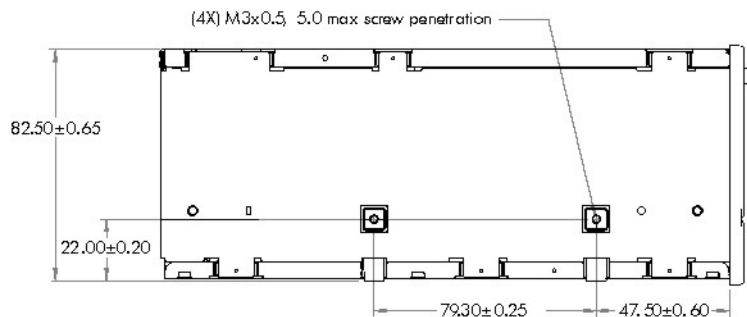
		Fibre Channel	SCSI	SAS
<b>Internal</b>	<i>width:</i>	146 mm (5.75")		
	<i>height:</i>	82.5 mm (3.25")		
	<i>depth:</i>	203 mm (8")		
<b>External</b>	<i>width:</i>	n/a	208 mm (8.2")	
	<i>height:</i>	n/a	121 mm (4.75")	
	<i>depth:</i>	n/a	298 mm (11.75")	

### Full-height drives

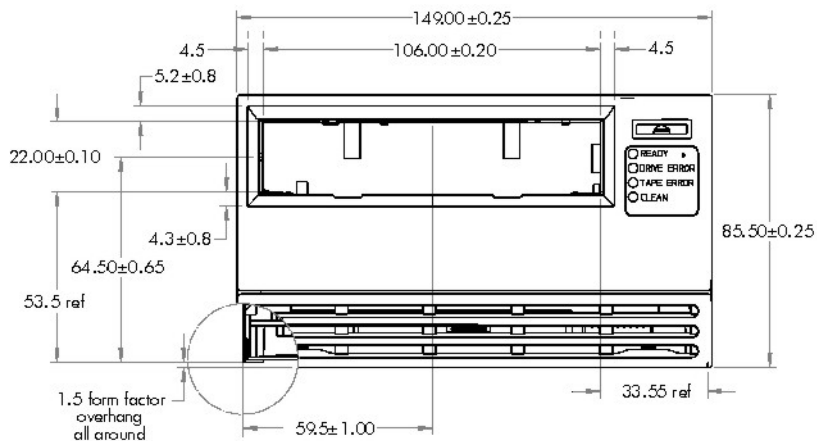
Figure 1 Plan



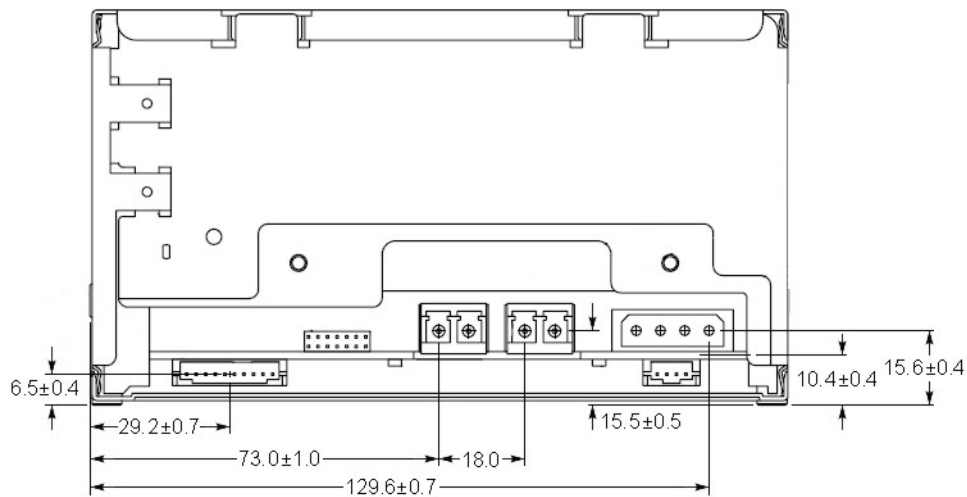
**Figure 2** Side



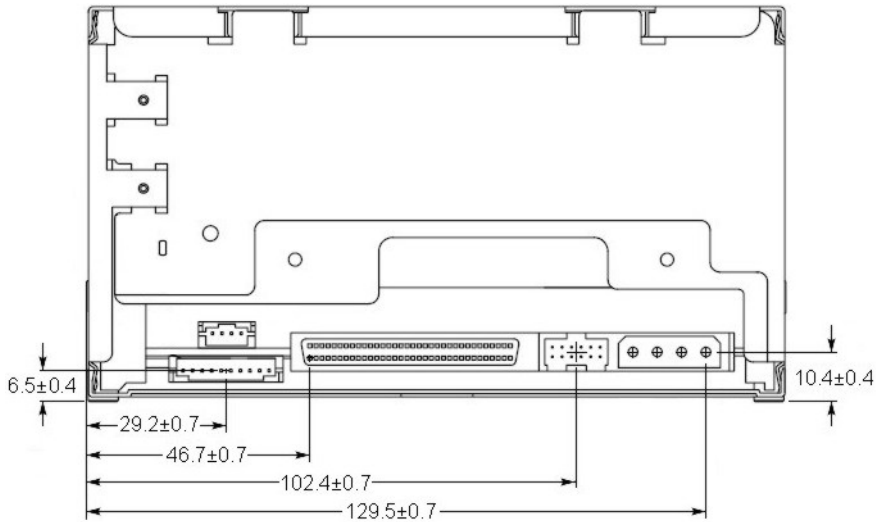
**Figure 3** Front



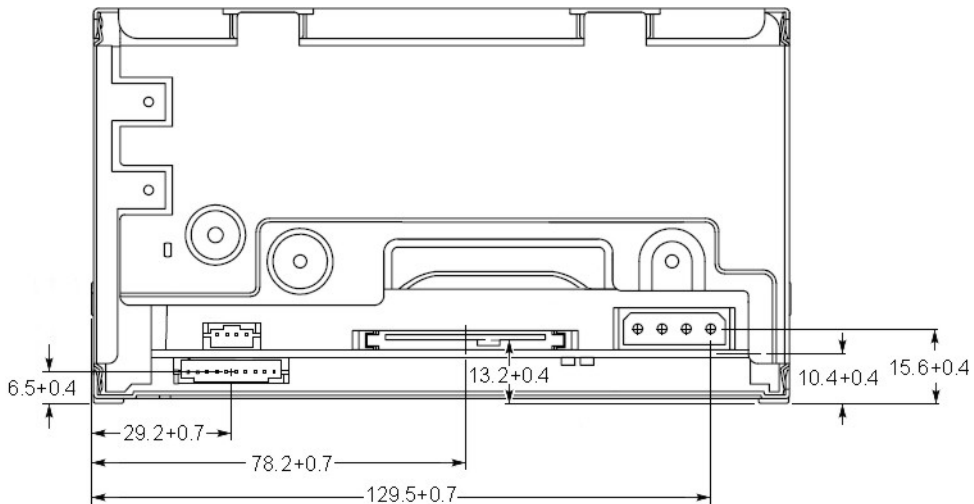
**Figure 4** Rear view—Fibre Channel



**Figure 5** Rear View—SCSI



**Figure 6** Rear View—SAS



## Product weight

<b>Internal*</b>	2.24 kg (4.94 lb)
<b>External</b>	5.33 kg (11.75 lb)

\*including front panel and ESD bag but excluding rails

## Drive orientation

HP LTO Ultrium drives will operate in 0°, -90° and +90° orientations 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

**NOTE:** SAS drives should be powered from the normal rear panel connector, not through the power part of the SAS connector.

Drives are specified to operate at  $5V \pm 5\%$  and  $12V \pm 10\%$ . 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	FC Drives		SCSI Drives		SAS Drives	
	5V	12V	5V	12V	5V	12V
Max voltage	5.25V	13.2V	5.25V	13.2V	5.25V	13.2V
Min voltage	4.75V	10.8V	4.75V	10.8V	4.75V	10.8V
Max steady-state current	4.2A	0.75A	tbdA	tbdA	tbdA	tbdA
Max transient current	4.5A	2.5A	tbdA	tbdA	tbdA	tbdA
Max steady-state power	21W	9W	tbdW	tbdW	tbdW	tbdW
Max transient power	22.5W	30W	tbdW	tbdW	tbdW	tbdW
Max noise/ripple	tbd mVpp	tbd mVpp	tbd mVpp	tbd mVpp	tbd mVpp	tbd mVpp

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

### Power consumption


	Internal Drives	External Drives
Power Requirements	<30W (<52W max.)	100–240 VAC 50/60 Hz 0.8A max.
5V DC	4.2A typ. (4.5A max.)	
12V DC	0.8A typ. (2.5A max.)	

Activity	FC Drives		SCSI Drives		SAS Drives	
	Average	Peak	Average	Peak	Average	Peak
Power-up	11.23W	22.10W	tbdW	tbdW	tbdW	tbdW
Idle	11.55W	11.99W	tbdW	tbdW	tbdW	tbdW
Load	14.97W	34.56W	tbdW	tbdW	tbdW	tbdW
Unload	16.14W	42.54W	tbdW	tbdW	tbdW	tbdW
Write (motor start-up)	27.76W	51.71W	tbdW	tbdW	tbdW	tbdW
Read (motor start-up)	24.19W	44.60W	tbd	tbd	tbd	tbd

Activity	FC Drives		SCSI Drives		SAS Drives	
	Average	Peak	Average	Peak	Average	Peak
Space to EOD	19.98W	37.59W	tbd	tbd	tbd	tbd
Erase	29.89W	51.97W	tbd	tbd	tbd	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 server enclosures and in external desktop enclosures to verify EMC performance against the regulatory standards in force at the time of introduction.

Products will comply with new regulatory standards by or before the date of withdrawal of the superseded standards, during their production life.

### ITE emissions

Parameter	Standards	
	International	European Economic Area
<b>Radiated and conducted*</b>	CISPR 22:2005 FCC CFR 47 Part 15, referencing ANSI C63.4-2003 (U.S.A. only)	EN 55022:2006
<b>Harmonic current*</b>	IEC 61000-3-2:2000 + Amendment 1:2001 + Amendment 2:2004	EN 61000-3-2:2000 + /A2:2005
<b>Voltage fluctuations and flicker*</b>	IEC 61000-3-3:1994 + Amendment 1:2001	EN 61000-3-3:1995 + /A1:2001

\*The marked standard applies to external (desktop) products only

### ITE immunities

Parameter	Standards	
	International	European Economic Area
<b>Generally</b>	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>
<b>Electrostatic discharge</b>	IEC 61000-4-2:1995	EN 61000-4-2:1995
<b>Radiated RF electromagnetic field</b>	IEC 61000-4-3:1995	EN 61000-4-3:1995
<b>Electrical fast transient/Burst*</b>	IEC 61000-4-4:1995	EN 61000-4-4:1995
<b>Surge*</b>	IEC 61000-4-5:1995	EN 61000-4-5:1995
<b>Conducted disturbances by RF fields*</b>	IEC 61000-4-6:1996	EN 61000-4-6:1996
<b>Power frequency magnetic field</b>	IEC 61000-4-8:1993	EN 61000-4-8:1993
<b>Voltage dips, interruptions &amp; variations*</b>	IEC 61000-4-11:1994	EN 61000-4-11:1994

\*The marked standard applies to external (desktop) products only

## DC magnetic field interference

IATA Dangerous Goods Regulations, 2007, 48th edition

# 5 Environmental

## Climatics

These apply to the mechanism unless otherwise noted. For the environmental specification of media, see [Chapter 7 on page 23](#).

### Operating

Parameter	Specification
Operating temperature with media	at 6 cfm airflow: 10°C to 35°C (50°F to 95°F) at 8 cfm airflow: 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 swept 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 g <sup>2</sup> /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, +ve and -ve direction 1800 shock pulses per test

Parameter	Specification
Non-operating swept sine vibration	0.75G pk 5–500 Hz @ 1 octave/min with 5 min dwell at peak resonance
Non-operating random vibration	2.41G rms 5–500 Hz 5–100 Hz 0.001961 g <sup>2</sup> /Hz 100–137 Hz @ -6 dB/octave 137–350 Hz 0.01079 g <sup>2</sup> /Hz 350–500 Hz @ -6 dB/octave 500 Hz 0.0050 g <sup>2</sup> /Hz
Non-operating shock	90G 3 ms half-sine (no damage) 33G 11 ms half-sine (no damage) 30G 26 ms trapezoidal (no damage)
Transportation swept 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 (30 min/axis) 5–100 Hz 0.015 g <sup>2</sup> /Hz 100–200 Hz @ -6 dB/octave 200 Hz 0.0038 g <sup>2</sup> /Hz
Package drop	0.91m (36 in) 10 vertical impacts (6 faces and 4 bottom corners)

## Noise

Parameter	Specification
Operating acoustic noise	<5.0 bel sound power

## Airflow

HP LTO Ultrium drives require forced airflow from front to back.

<b>Airflow (operating and non-operating)</b>	
Full-height drives	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	Country	Referenced Standard
Underwriters Laboratories (UL)	USA	UL 60950-1 First Edition
Canadian Standards Association (CSA)	USA/Canada	CSA 22.2 60950-1-03
TÜV	Germany	EN 60950-1:2001
Low Voltage Directive (CE)	Europe	IEC 60950-1:2001
Official Mexican Norm (NOM)	Mexico	NOM-0190SCFI-2998
Instituto Argentino de Normalización	Argentina	
Zavod Za Ispitvanje Kvalitete Robe (ZIK)	Croatia	
Magyar Elektrotechnikai Ellenorzo Intezet (MEEI)	Hungary	
Polski Ventrum Badan I Certyfikacji (PCBC)	Poland	
CNCTEMA CEPTHΦ HKLIHHΓ OCT P (GOSH)	Russia	GOST R 50377
Slovenian Institute of Quality (SIQ)	Slovenia	
TÜV-PS (CB Report)	Multiple	IEC 60950-1:2001
Productivity and Standards Board (PSB)	Singapore	

### Required agency approvals

Agency	Country	National Standard
Federal Communications Commission (FCC)	USA/Canada	ANSI C63.4:2003
EMC Directive (CE)	Europe	EMC
C-Tick	Australia	AS/NZS 3548 (EN 55022, CISPR22)
Ministry of Commerce	New Zealand	EMC
Voluntary Control Council for Interference (VCCI)	Japan	EMC: CISPR 22:1997
Radio Research Laboratory (RRL)	Korea	MIC No.1996-18 (EN55022)
Bureau of Commodity Inspection and Quarantine (BCIQ)	Taiwan	EMC
Zavod Za Ispitvanje Kvalitete Robe (ZIK)	Croatia	EMC
Kirkozlesi Fofelugyelet (MEEI)	Hungary	EMC
Elektrotechnicky vyskumny a projektovy	Slovakia	EMC

<b>Agency</b>	<b>Country</b>	<b>National Standard</b>
South African Bureau of Standards (SABS)	South Africa	EMC
СНСТЕМА СЕРТНΦ НКЛНННГ ОСТ Р (GOSH)	Russia	R 51318.22-99 & R 50839=2000

## 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
C7974A	U4	1600 GB	Read and write
C7974W	U4 WORM	1600 GB	Write once, read many times
C7973A	U3	800 GB	Read and write
C7973W	U3 WORM	800 GB	Write once, read many times
C7972A	U2	400 GB	Read

\*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.

		LTO 2	LTO 3	LTO 4
<b>Tape</b>	Base film:	PEN (Poly-Ethylene-Naphthalate)		
	Tape length:	609m	680m	820m
	Tape length used for data:	580m	648m	783m
	Tape width:	12.65 mm	12.65 mm	12.65 mm
	Tape thickness:	8.9±0.3 µm	8.0±0.3 µm	6.6±0.3 µm
	Tape dimensional stability:	1200 ppm	1200 ppm	900 ppm
	Maximum tape speed:	7.29 m/s		
	Rewind speed:	7.00 m/s		
	Durability:	1,000,000 passes		
	<b>Cartridge</b>	Width:	105.4±0.30 mm	
Depth:		102.0±0.30 mm		
Height:		21.5±0.25 mm		
Weight:		0.220 kg		
<b>Recording layout</b>	Track pitch:	20.17 µm	14.3 µm	11.48 µm
	Track density (TPI):	1260	1773	2212
	Data tracks:	512	704	896
	Data channels:	8	16	16
	Number of wraps:	64	44	56
	Number of bands:	4	4	4
	Bit density:	7.40 Kb/mm	9.64 Kb/mm	13.52 Kb/mm
<b>Cartridge memory capacity</b>		4096 bytes	4096 bytes	8192 bytes

## 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)

Archival storage is recommended for cartridges that need to be stored more than six months. 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)	20% 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 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 (maximum 10 to 20 mm). The best error rate performance occurs at short distances.



- The memory can be read from below (by a drive) or the front (in libraries).
- 8192 bytes
- Organized as 255 x 32 byte blocks
- >500K write cycles, 20 year data retention life
- Write/read size is word-wide (2 bytes) or block-wide (32 bytes)

#### Further information

- For suggestions of how to make use of cartridge memory in libraries, see “LTO Cartridge Memory (LTO-CM)” in Chapter 5, “Supporting LTO Ultrium Features” in *Software Integration*, Volume 2 of the HP LTO Ultrium Technical Manual.



## 8 LTO Ultrium format standard

### Compatibility

HP LTO Ultrium 4 drives are specified to interchange data cartridges with other tape drives that comply to the LTO U-28, U-316 and U-416 specification documents:

Capacity (2:1 compression)	Format	Write	Read
1600 GB WORM	LTO Ultrium-4	Yes	Yes
1600 GB (820m)	LTO Ultrium-4	Yes	Yes
800 GB WORM	LTO Ultrium-3	Yes	Yes
800 GB (680m)	LTO Ultrium-3	Yes	Yes
400 GB (580m)	LTO Ultrium-2	No	Yes
200 GB (580m)	LTO Ultrium-1	No	No
100 GB (290m)	LTO Ultrium-1	No	No

This specification only applies when:

- Cartridges carry the LTO 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 in good condition.
- Environmental conditions (including DC voltage supplies) are within the specified limits.

### Future compatibility

In future, HP LTO 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 LTO Ultrium drives will always maintain write and read compatibility with other manufacturers' LTO 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

### Full-height drives

Maximum transfer rate	<i>Native:</i>	120 MB/s
	<i>Compressed (2:1):</i>	240 MB/s
Streaming native data rate range (3:1)		40–120 MB/s (LTO 4) 27–80 MB/s (LTO 3) 13.7–35.6 MB/s (LTO 2)

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:

Compression engine bandwidth	360 MB/s
Encryption engine bandwidth	360 MB/s

The drive will match the throughput of any host up to the maximum native transfer rate multiplied by the current compression ratio. There is no performance penalty for hosts that are slower than the maximum. This capability is accomplished with a 128 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	6.20 m/s (LTO 4)
	5.32 m/s (LTO 3)
	6.20 m/s (LTO 2)
Tape rewind speed	7.00 m/s

## Timings

### Capacity full backup times

The following table shows approximate backup times for supported tape cartridges:

Cartridge	Time
1600 GB LTO 4	2.24 hours
800 GB LTO 3	1.76 hours
400 GB LTO 2 ( <i>read only</i> )	1.87 hours

### Load/unload times

	Standard cartridge	WORM Cartridge*
Typical load time to BOT, ready to read or write	<19s	<22s
Unload time, excluding rewind	<19s	<22s
Automation eject (tape unthreaded)	<1s	<1s

\* Uninitialized WORM cartridges can take up to 70s to load.

### Access times (time to data)

		Time
Average access time from BOT	1600 GB LTO 4:	62s
	800 GB LTO 3:	52s
	400 GB LTO 2:	46s
Maximum access time from BOT	1600 GB LTO 4:	129s
	800 GB LTO 3:	107s
	400 GB LTO 2:	95s

### Other times

Parameter	Time
Mean reposition time	2.50s
Turn-around time at end of wrap	1.5s max.
Time to rewind EOT—BOT	124s (U4), 102s (U3), 92s (U2)
Time to rewind MOT—BOT at 7.0 m/s	62s (U4), 51s (U3), 46s (U2)
Cleaning time with a cleaning cartridge	58–152s



# 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 LTO 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 LTO Ultrium drives:

Mandatory Commands	
<b>00h</b>	Get Drive Info
<b>01h</b>	Load
<b>02h</b>	Unload
<b>03h</b>	Get Drive Status
<b>04h</b>	Set Drive Configuration
<b>05h</b>	Get Drive Configuration
<b>06h</b>	Reset
<b>07h</b>	Set Baud Rate
<b>08h</b>	No Op
<b>09h</b>	Get Error Info
<b>0Ah</b>	Acknowledge Attention

Optional Commands	
<b>40h</b>	Send SCSI Command
<b>42h</b>	Send Firmware Image
<b>43h</b>	Get Firmware Segment
<b>49h</b>	Get Buffer Size
<b>4Ah</b>	Send Firmware Segment
<b>4Bh</b>	Set Time
<b>4Ch</b>	Get Time



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