

HP LTO Ultrium tape drives technical reference manual

Volume 4: specifications

LTO 5 drives

Abstract

This is one of five volumes that document HP LTO Ultrium 5 tape drives (Fibre Channel and SAS). This volume details specifications. See [Chapter 11](#) on page 43 for details of the other guides.



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<http://www.hp.com/go/storagewarranty>

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1 Features

Feature	Specification
Recording format	Linear Serpentine Ultrium-5 and Ultrium-4. LTO Ultrium-3 tapes can be read but not written.
Data compression	ALDC
Data encoding method	16-channel 32/33 RLL NPML
Variable speed recording	47–140 MB/s Ultrium-5 ¹
Read-While-Write	Standard—data is verified immediately after it is written
Auxiliary memory in cartridge (CM)	Standard 8K LTO-CM as part of Ultrium format
Data interfaces	FC: Full height: 8 Gb/s dual port Fibre Channel Half height: 8 Gb/s single port Fibre Channel
	SAS: 6 Gb/s dual port SAS
Library interface (ACI/ADI)	Bi-directional RS422 (serial protocol RS422 9600 to 153600 baud)
Management Interface (iADT)	Ethernet (10Base-T and 100 Base-TX)
Main data buffer size	256 MB
Burst buffer size	2 MB (FC and SAS—embedded DRAM)

¹Decimal MB/s including wrap turn-around and up to 1% dataset re-writes.

Data security features

Description	Specification
Data encryption	AES-GCM 256
Certification level	FIPS140–2 certification level 1

Tape partitioning features

Description	Specification
Number of partitions	2

Description	Specification
Data encryption	Supported as per U-516 LTO5 format specification
WORM cartridge	Partitioning a WORM cartridge is not supported as per U-516 Annex L

2 Physical specification

Dimensions

		Full-height	Half-height
Internal	<i>width:</i>	146.07 ± 0.25 mm (5.75")	146.05 ± 0.25 mm (5.75")
	<i>height:</i>	82.5 ± 0.65 mm (3.25")	41.65 ± 0.25 mm (1.64")
	<i>depth:</i>	203.0 ± 0.8 mm (7.99")	206 ± 0.25 mm (8.11")*
External (SAS only)	<i>width:</i>	218 mm (8.58")	224 mm (8.82")
	<i>height:</i>	120 mm (4.72")	79 mm (3.11")
	<i>depth:</i>	297 mm (11.69")	301 mm (11.85")

Full-height drives

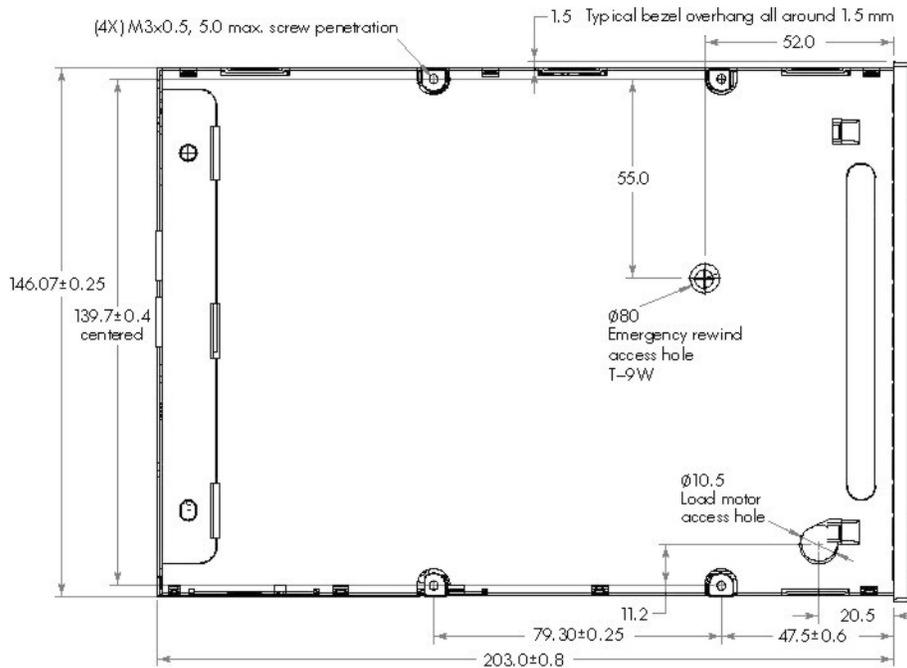


Figure 1 Full-height drives—plan

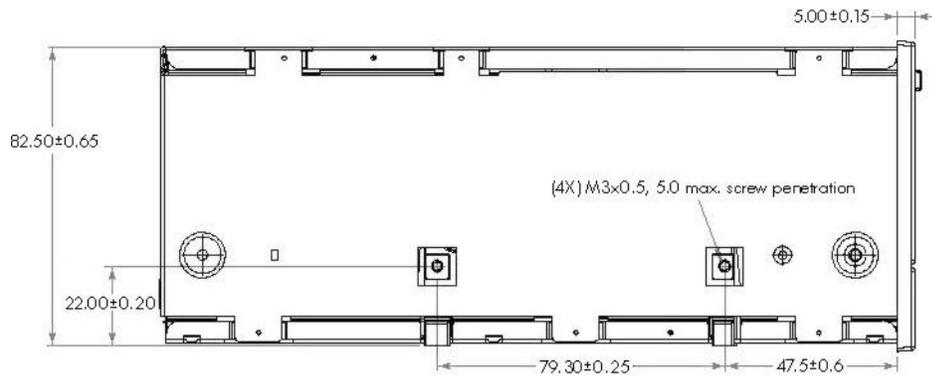


Figure 2 Full-height drives—side

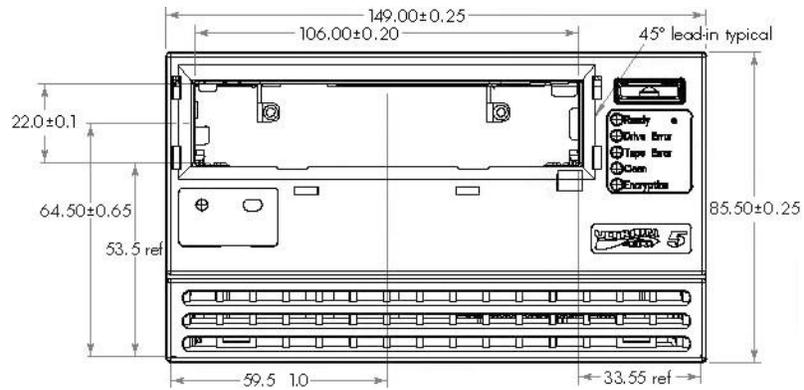


Figure 3 Full-height drives—front



NOTE:

The diagram shows the Automation bezel.

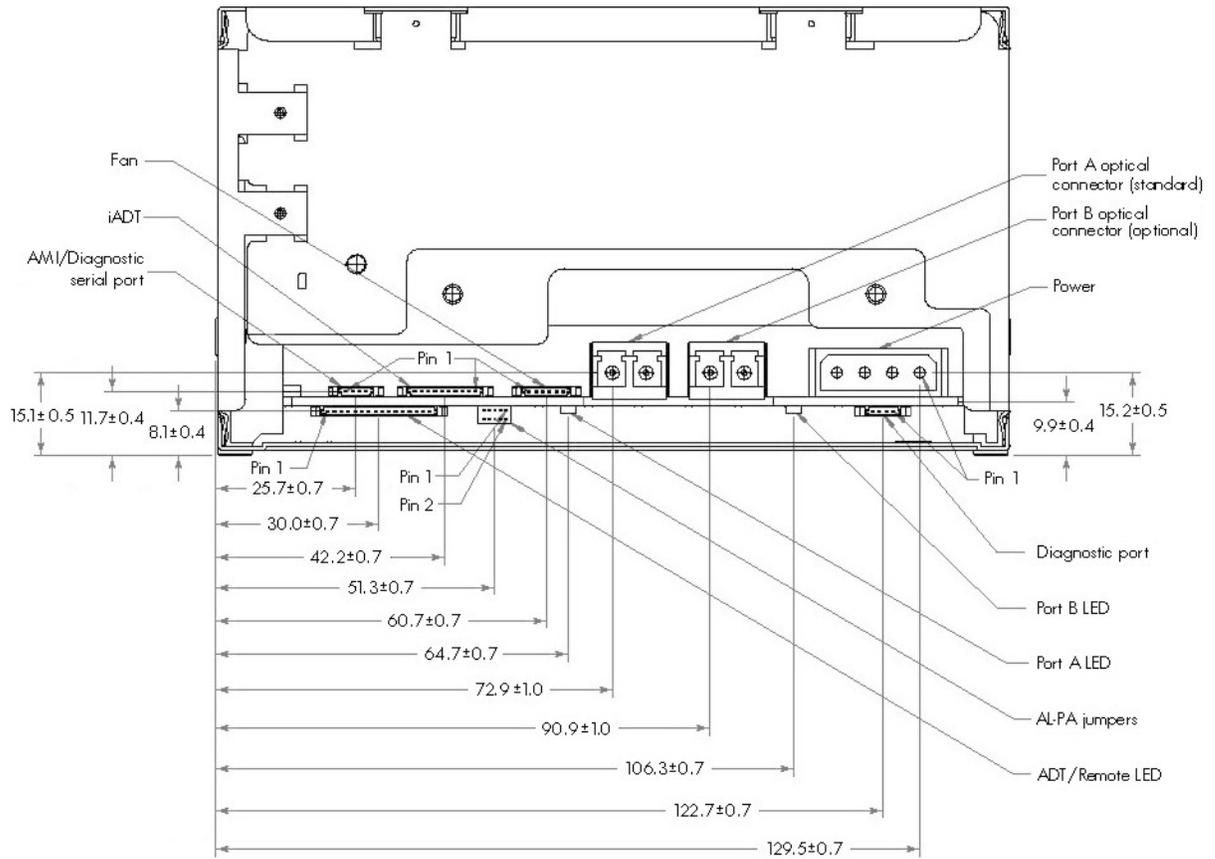


Figure 4 Full-height drives—rear view (Fibre Channel)

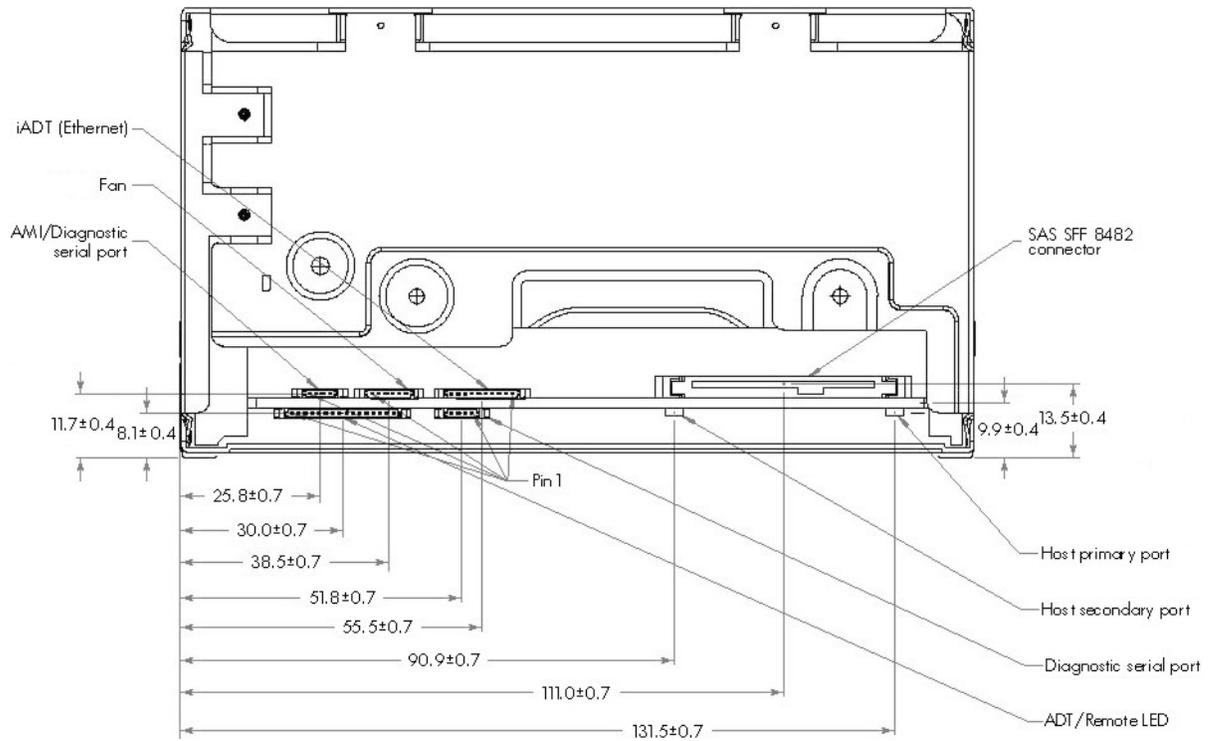


Figure 5 Full-height drives—rear view (SAS)

Half-height drives

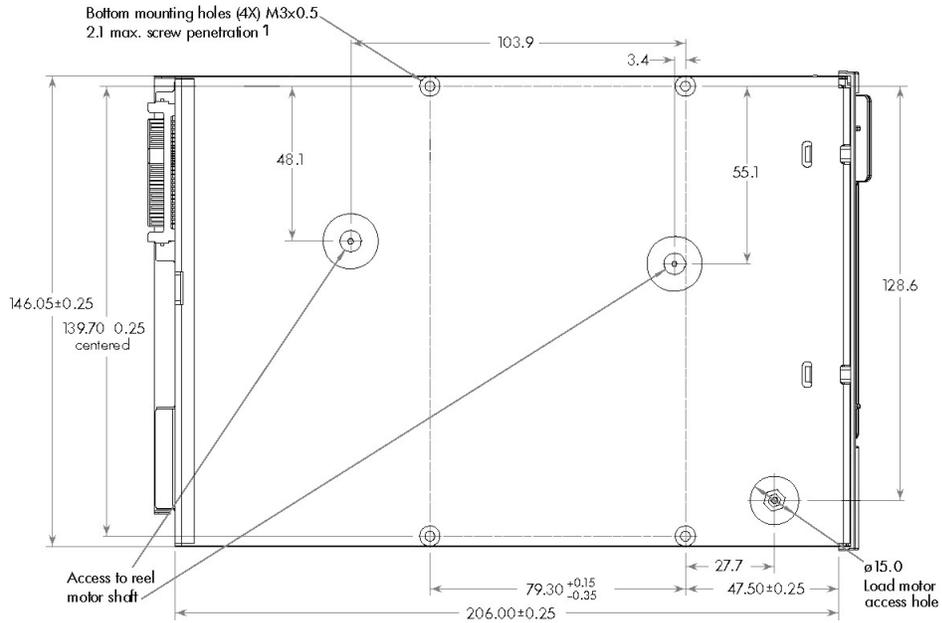


Figure 6 Half-height drives—plan

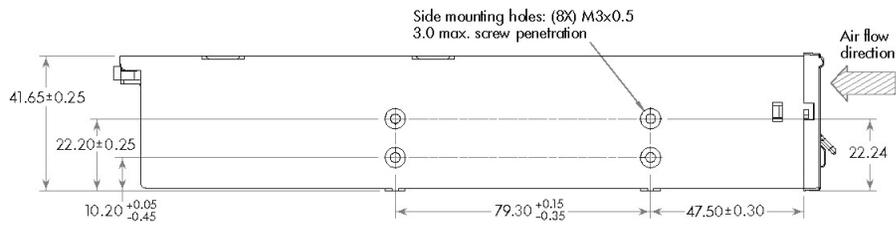


Figure 7 Half-height drives—side

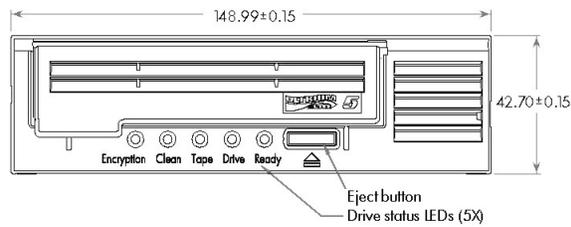


Figure 8 Half-height drives—front

 **NOTE:**

The diagram shows the System bezel.

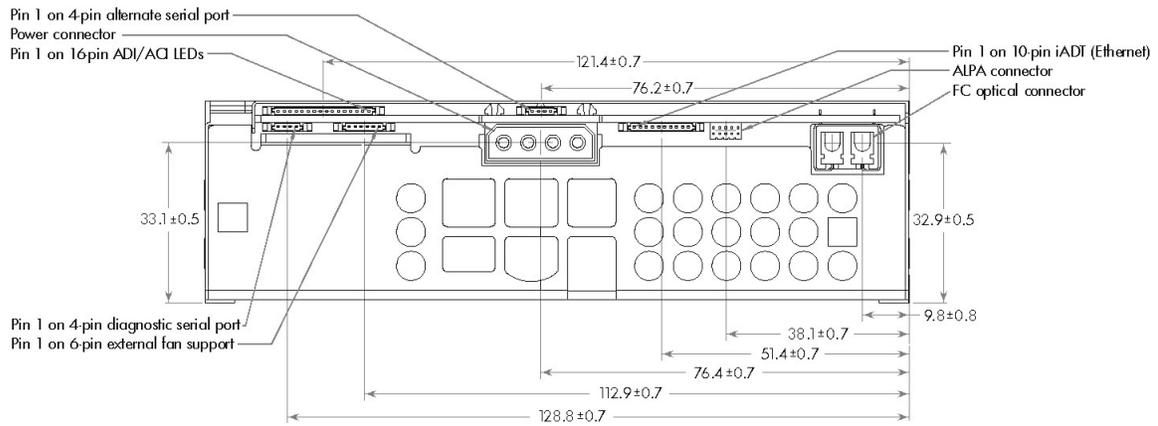


Figure 9 Half-height drives—rear view (Fibre Channel)

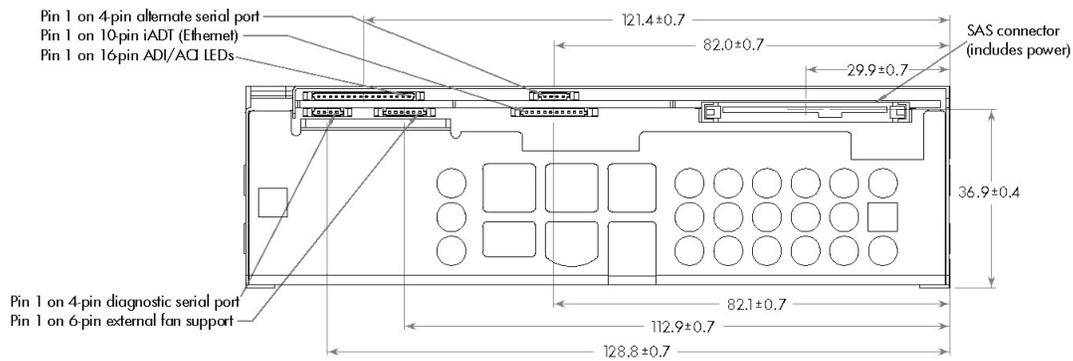


Figure 10 Half-height drives—rear view (SAS)

Product weight

	Full-height	Half-height
Internal*	2.26 kg (4.98 lb)	1.41 kg (3.11 lb)
External	5.31 kg (11.71 lb)	3.71 kg (8.18 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

DC voltage specifications

	5V	12V
Maximum voltage	5.25V	13.2V
Minimum voltage	4.75V	10.8V
Typical current	3.6A	0.50A
Maximum current	<3.7A	<3.0A

Maximum currents drawn from the power supplies

Full-height Fibre Channel drives

The following are the maximum currents drawn from the power supplies for the HP LTO Ultrium 5 full-height tape drive fitted with a single SFP transceiver from a sample of six drives.

Mode	5V (avg)	5V (max) 1 ms RMS	5V (max) 20 ms RMS	12V (avg)	12V (max) 1 ms RMS	12V (max) 20 ms RMS
Power on	0.88	1.31	0.71	0.10	2.12	0.99
Idle	1.19	n/a	n/a	0.07	n/a	n/a
Unload	1.55	1.68	1.86	0.44	1.90	1.88
Load ¹	1.32	1.58	1.81	0.37	1.48	1.26
Write ¹	3.54	3.61	3.56	0.47	2.74	1.97
Read	2.84	2.91	2.91	0.46	1.97	1.58
Space to EOD	2.06	2.04	2.1	0.62	1.97	2.03
Erase ¹	3.32			0.44		

¹ Write, Read and Erase average values are taken over two full wraps
Write and Read RMS values include the peaks from the motor start-up ramps.

Full-height SAS drives

The following are the maximum currents drawn from the power supplies for the HP LTO Ultrium 5 full-height SAS drive from a sample of six drives.

Mode	5V (avg)	5V (max) 1 ms RMS	5V (max) 20 ms RMS	12V (avg)	12V (max) 1 ms RMS	12V (max) 20 ms RMS
Power on	1.09	1.33	0.74	0.10	2.13	0.68
Idle	1.22	n/a	n/a	0.10	n/a	n/a
Unload	1.59	1.70	1.68	0.45	1.997	1.68
Load	1.34	1.61	1.60	0.37	1.45	1.26
Write ²	3.57	3.63	3.58	0.51	2.92	1.99
Read ²	2.91	3.01	2.97	0.50	1.98	1.60
Space to EOD	2.05	2.03	2.01	0.60	2.20	2.03
Erase ²	3.35			0.48		

² Write, Read and Erase average values are taken over two full wraps.
Write and Read RMS values include the peaks from the motor start-up ramps.



NOTE:

HP Ultrium LTO5 SAS tape drives are powered via the SAS connector and do not have a regular 4-pin power connector.

Half-height SAS drives

The following are the maximum current drawn from the power supplies for the HP LTO Ultrium 5 half-height SAS tape drive from a sample of six drives.

Mode	5V (avg)	5V (max) 1 ms RMS	5V (max) 20 ms RMS	12V (avg)	12V (max) 1 ms RMS	12V (max) 20 ms RMS
Power on	0.83	1.44	0.71	0.09	1.50	0.95
Idle	1.19	n/a	n/a	0.07	n/a	n/a
Unload	1.54	1.61	1.59	0.44	2.33	1.79
Load	1.24	1.54	1.53	0.39	1.40	1.37
Write ³	3.48	3.68	3.60	0.50	2.48	1.24
Read ³	2.89	2.97	2.92	0.49	1.37	0.98
Space to EOD	2.06	2.09	2.07	0.56	2.09	2.09

Mode	5V (avg)	5V (max) 1 ms RMS	5V (max) 20 ms RMS	12V (avg)	12V (max) 1 ms RMS	12V (max) 20 ms RMS
Erase ³	3.36			0.47		

³ Write, Read and Erase average values are taken over two full wraps. Write and Read RMS values include the peaks from the motor start-up ramps.



NOTE:

HP Ultrium LTO5 SAS tape drives are powered via the SAS connector and do not have a regular 4-pin power connector.

Half-height Fibre Channel drives

The following are the maximum current drawn from the power supplies for the HP LTO Ultrium 5 half-height FC tape drive from a sample of six drives.

Mode	5V (avg)	5V (max) 1 ms RMS	5V (max) 20 ms RMS	12V (avg)	12V (max) 1 ms RMS	12V (max) 20 ms RMS
Power on	0.92	1.46	0.76	0.07	1.50	0.76
Idle	1.19	n/a	n/a	0.07	n/a	n/a
Unload	1.54	1.61	1.58	0.42	2.36	1.17
Load	1.27	1.61	1.48	0.41	2.73	1.70
Write ⁴	3.36	3.54	3.45	0.45	2.50	1.24
Read ⁴	2.83	2.94	2.88	0.45	1.13	1.10
Space to EOD	2.04	2.08	2.06	0.54	2.23	1.26
Erase ⁴	3.19			0.42		

⁴ Write, Read and Erase average values are taken over two full wraps. Write and Read RMS values include the peaks from the motor start-up ramps.



NOTE:

Half-height FC values are preliminary until the final hardware is available.

Power consumption specifications

Full-height drives

The following are the maximum power consumptions drawn from the power supplies for the HP LTO Ultrium 5 full-height tape drive from a sample of six drives.

Description	FC internal			SAS internal		
	Average	Peak 1 ms RMS	Peak 20 ms RMS	Average	Peak 1 ms RMS	Peak 20 ms RMS
Power	<23W	<51W	<41W	<24W	<54W	<42W
5V DC	3.54A	3.61A	3.57A	3.57A	3.63A	3.58A
12V DC	0.47A	2.74A	1.97A	0.51A	2.92A	1.99A
Power consumption						
Power-up	5.58	31.74	15.29	6.70	31.84	14.84
Idle	6.60	n/a	n/a	6.90	n/a	n/a
Unload	12.76	30.58	30.19	12.81	31.58	28.42
Load	10.77	25.54	22.93	11.19	25.44	23.06
Write	22.93	50.12	40.82	23.32	53.12	41.65
Read	19.45	38.21	33.24	20.13	38.83	34.05
Space to EOD	17.76	33.40	34.11	17.30	36.54	34.16
Erase	21.93			22.44		

Half-height drives

The following are the maximum power consumptions drawn from the power supplies for the HP LTO Ultrium 5 half-height tape drive from a sample of six drives.

Description	FC internal			SAS internal		
	Average	Peak 1 ms RMS	Peak 20 ms RMS	Average	Peak 1 ms RMS	Peak 20 ms RMS
Power	<23W	<48W	<32W	<24W	<48W	<36W
5V DC	3.36A	3.54A	3.45A	3.58A	3.68A	3.60A
12V DC	0.45A	2.73A	1.71A	0.50A	2.48A	2.09A
Power consumption						

Description	FC internal			SAS internal		
	Average	Peak 1 ms RMS	Peak 20 ms RMS	Average	Peak 1 ms RMS	Peak 20 ms RMS
Power-up	5.30	24.57	12.38	5.20	24.58	14.82
Idle	6.58	n/a	n/a	6.65	n/a	n/a
Unload	12.74	36.14	28.24	12.84	35.69	28.97
Load	11.21	40.09	27.71	10.80	24.56	23.63
Write	22.15	47.27	31.85	23.17	47.86	32.16
Read	19.47	28.19	27.59	20.07	31.14	26.16
Space to EOD	16.66	36.92	25.16	16.58	35.60	35.54
Erase	20.90			22.16		



NOTE:

Half-height FC values are preliminary until the final hardware is available.

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.

EMC test specification

The following are the specifications for an internal drive configuration.

General standard	Reference standards	Test description	Test level/class
CISPR 22:1997	CISPR 16-1:1993	Radiated Emissions	Class B
EN 55022:1998	CISPR 16-1:1993	Radiated Emissions	Class B
VCCI	CISPR 22:1997	Radiated Emissions	Class B
FCC CFR 47 Part 15	ANSI C63.4:2003	Radiated Emissions	Class B 30 MHz – 2.0 GHz
EN 55024:1998+A1+A2 CISPR 24:1997+A1 +A2 EN 300 386:2001 + Extended Additional Requirements	EN/IEC 61000-4-2:1995	Electrostatic Discharge	10.5 kV Air and 6.3 kV Contact
	EN/IEC 61000-4-3:1995	Radiated RF Interference	12 V/m 80% AM, 80–2000 MHz
	EN/IEC 61000-4-3:1995	Radiated RF Interference	3 V/m, 1 KHz PM, 1–4 GHz

The following are the specifications for an external drive configuration.

General standard	Reference standards	Test description	Test level/class
FCC CFR 47 Part 15	ANSI C63.4:2003	Radiated Emissions	Class B 30 MHz—2 GHz
VCCI	CISPR 22:1997	Emissions	Class B
CISPR 22:1997	CISPR 16-1:1993	Emissions	Class B
EN 55022:1998	CISPR 16-1:1993	Emissions	Class B

General standard	Reference standards	Test description	Test level/class
EN/IEC 61000-3-3	IEC 61000-3-3:1994 and A 1 : 2001	Flicker	Pst = Plt = 0.65
EN/IEC 61000-3-2	IEC 61000-3-2:2000	Harmonics	Class A
	EN/IEC 61000-4-2:1995	Electrostatic discharge	10.5 kV Air and 6.3 kV Contact
	EN/IEC 61000-4-3:1995	Radiated RF interference	80-2000 MHz, 12 V/m AM
	EN/IEC 61000-4-3:1995	Radiated RF interference	1-4 GHz, 3 V/m PM
EN 55024:1998+A1 CISPR 24:1997+A1 EN 300 386:2001 + Extended Additional Requirements	EN/IEC 61000-4-4:1995	Fast transients bursts	2.2 kV AC Power Port
	EN/IEC 61000-4-4:1995	Fast transients bursts	1.1 kV Signal Port
	EN/IEC 61000-4-5:1995	Lightning surge	1.65 kV L-L
	EN/IEC 61000-4-5:1995	Lightning surge	3.3 kV L-E
	EN/IEC 61000-4-5:1995	Lightning surge	2.2 kV L-E and 1.1 kV L-L
	EN/IEC 61000-4-6:1996	Conducted RF field	5V (all ports)
	EN/IEC 61000-4-11:1994	Voltage dip	30% 0.5s and 1s
	EN/IEC 61000-4-11:1994	Voltage dip	100% 10 ms and 20m
	EN/IEC 61000-4-11:1994	Voltage dip	100% 5s

ITE emissions

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

*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 [Media](#).

Operating

Parameter		Specification
Operating temperature with media	<i>Full-height:</i>	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)
	<i>Half-height:</i>	at 5 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 $\mu\text{g}/\text{m}^3$

Dynamics

Description	Mode	Specification
Vibration (Brick)	Operating (3 axes)	<i>Random</i> : 0.31G rms 5 to 500 Hz $0.000194 \text{ g}^2/\text{Hz}$
		<i>Swept Sine</i> : 0.31G peak 5 to 500 Hz @ 1 octave/min 15 minute dwell at peak resonance
	Operating Margin Characterized* (3 axes)	<i>Random</i> : 1.0 G rms 5 to 500 Hz $0.00202 \text{ g}^2/\text{Hz}$
		<i>Swept Sine</i> : <i>Full Height</i> : 0.75G peak 5 to 500 Hz @ 1 octave/min <i>Half Height</i> : 0.5G peak 5 to 500 Hz @ 1 octave/min 15 min dwell at major resonance
	Non-Operating (3 axes)	<i>Random</i> : (approx. 2.41G rms 5 to 500 Hz) 5–100 Hz $0.001961 \text{ g}^2/\text{Hz}$ 100–137 Hz @ –6 dB/octave 137–350 Hz $0.01079 \text{ g}^2/\text{Hz}$ 350–500 Hz @ –6 dB/octave 500Hz $0.0052 \text{ g}^2/\text{Hz}$
<i>Swept sine</i> : <i>Full Height</i> : 1.0G peak, 5 to 500Hz @ 1 octave/min <i>Half Height</i> : 0.75G peak, 5 to 500 Hz @ 1 octave/min 5 minute dwell at major resonance		
Non-Operating Margin Characterized* (3 axes)	<i>Swept sine</i> : <i>Full Height</i> : 1.5G peak, 5 to 500 Hz @ 0.5 octave/min <i>Half Height</i> : 1.0G peak, 5 to 500 Hz @ 0.5 octave/min 15 minute dwell at major resonance	
Shock (Brick—all six faces)	Operating	5G peak 3 ms (half sine)—no performance change 2G peak 11 ms (half sine)—no performance change 8G peak 11 ms (half sine)—no data loss Pulse Rate 1 pulse every 10 sec, +ve and –ve direction 1800 shock pulses per test
	Operating Margin Characterized*	62G peak 2 ms (half sine)—no data loss Pulse rate 1 pulse every 10 sec, +ve and –ve direction 600 shock pulses per test

Description	Mode	Specification
	Non-Operating	90G peak 3 ms (half sine)—no damage 33G peak 11 ms (half sine)—no damage (FH only) 30G peak 26 ms (trapezoidal)—no damage
	Non-Operating Margin Characterized *	200G peak 2.6 ms (half sine)—no damage with cartridge loaded and threaded
Handling Drop	Non-Operating	<i>Unpackaged Shock:</i> One drop per bottom corner free fall from 100 mm, while rotating about the edge on the other two corners, each corner stands on a 10 mm and 20 mm spacer respectively. Drop a total of four bottom corners
Transportation (Vibration—single pack)	Vibration (3 axes)	<i>Swept sine:</i> 0.5G peak 5–200–5 Hz @ 1 octave/min 5 min dwell at peak resonance <i>Random:</i> approx. 1.47G rms (30 min/axis) 5–100 Hz 0.015 g ² /Hz 100–200 Hz @ -6dB/octave 200 Hz 0.0038 g ² /H
		Drop height = 0.91m (36 in) 10 vertical impacts (6 faces and 4 bottom corners)
Transportation (Palletized—normal shipping axes only)	Vibration	<i>Swept sine:</i> 0.5 G peak 5–200–5 Hz @ 1 octave/min 5 min dwell at peak resonance
		<i>Random:</i> approx. 1.47G rms (30 min/axis) 5–100 Hz 0.015 g ² /Hz 100–200 Hz @ -6dB/octave 200Hz 0.0038 g ² /H
	Shock	Drop height = 0.30m (12 in) 5 impacts (1 vertical flat base, 4 rotational edges)

*HP test philosophy is to test the product to failure so that the product margin can be characterized against the normal operating and non-operating specifications.

Noise

Parameter	Specification
Operating acoustic noise	<5.0 bel sound power

Airflow

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

	Airflow (<i>operating and non-operating</i>)
Full-height drives	0.17 m ³ /min (6 cu ft/min) at 35°C ambient operation, rising to 0.23 m ³ /min (8 cu ft/min) for up to 40°C ambient operation, from front to back
Half-height drives	0.14 m ³ /min (5 cu ft/min) at 40°C ambient operation, from front to back

6 Safety

Safety and EMC agency requirements

Country	Agency	Scope	Config	FC	SAS	Notes
USA	UL	Safety	Internal	Y	Y	
			External	N/A	Y	
	FCC	EMC	—	Y	Y	Refer to DoC
Canada	CSA	Safety	—	Y	Y	Refer to UL
	ICES	EMC	—	Y	Y	Refer to DoC
Mexico	NOM	Safety	External	N/A	Y	
Europe	CE	Safety-EMC	Internal	Y	Y	DoC
			External	N/A	Y	DoC
Germany	TUV	Safety	Internal	N/A	Y	
			External	N/A	Y	
Russia	GOSH	Safety-EMC	External	N/A	Y	
South Africa	SABS	Safety-EMC	External	N/A	Y	
Taiwan	BSMI	Safety-EMC	Internal	N/A	Y	
			External	N/A	Y	
Korea	RRL	EMC	Internal	N/A	Y	
			External	N/A	Y	
Australia New Zealand	C-Tick	Safety-EMC	Internal	N/A	Y	
			External	N/A	Y	
Japan	VCCI	EMC	External	N/A	Y	

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
C7975A	Ultrium-5	3000 GB	Read and write
C7975W	Ultrium-5 WORM	3000 GB	Write once, read many times
C7974A	Ultrium-4	1600 GB	Read and write
C7974W	Ultrium-4 WORM	1600 GB	Write once, read many times
C7973A	Ultrium-3	800 GB	Read
C7673W	Ultrium-3 WORM	800 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. GB are decimal MB.

 **NOTE:**

The HP Ultrium LTO 5 tape drives does not support Ultrium-2 R/W and Ultrium-1 R/W cartridge (10, 30, 50 and 100 GB cartridges). HP recommends the use of the "set capacity" SCSI command to logically shorten standard cartridges for test purposes.

		Ultrium-5	Ultrium-4	Ultrium-3
Tape	<i>Base film:</i>	Metal Particle PEN (Poly-Ethylene-Napthalate) or equivalent	Metal Particle PEN (Poly-Ethylene-Napthalate)	
	<i>Tape length:</i>	846m	820m	680m
	<i>Tape length used for data:</i>	808m	783m	648m
	<i>Tape width:</i>	12.65 mm	12.65 mm	12.65 mm
	<i>Tape thickness:</i>	6.4-0.2/+0.3 μ m	6.6-0.2/+0.3 μ m	8.0 \pm 0.3 μ m
	<i>Tape dimensional stability:</i>	Total < 875 ppm Env. < 550 ppm Tension < 300 ppm Ageing < 200 ppm	900 ppm	1200 ppm

		Ultrium-5	Ultrium-4	Ultrium-3
	<i>Rewind speed:</i>	9.00 m/s		
	<i>Durability:</i>	1,000,000 passes		
Cartridge	<i>Width:</i>	105.4±0.30 mm		
	<i>Depth:</i>	102.0±0.30 mm		
	<i>Height:</i>	21.5±0.25 mm		
	<i>Weight:</i>	0.220 kg		
Recording layout	<i>Track pitch:</i>	8.10 μm	11.48 μm	14.3 μm
	<i>Track density (TPI):</i>	3136	2212	1773
	<i>Data tracks:</i>	1280	896	704
	<i>Data channels:</i>	16	16	16
	<i>Number of wraps:</i>	80	56	44
	<i>Number of bands:</i>	4	4	4
	<i>RLL recording bit density:</i>	15.143 Kb/mm (384.6 Kb/in)	13.52 Kb/mm (343.4 Kb/in)	10.24 Kb/mm (260.1 Kb/in)
Cartridge memory capacity		8192 bytes	8192 bytes	4096 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)

* The media is specified to operate down to 10% RH as a margin beyond the minimum specified for the operating drive (20%).

Storage (day-to-day)

Parameter	Specification
Ambient Temperature	16°C to 32°C (60°F to 90°F)
Relative Humidity (non-condensing)	20% to 80%

Parameter	Specification
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	5°C to 23°C (41°F to 73°F)
Relative Humidity (non-condensing)	20% to 60%
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 the *Software Integration Guide*, Volume 2 of the HP LTO Ultrium Technical Manual.

8 LTO Ultrium format standard

Compatibility

HP LTO Ultrium 5 drives are specified to interchange data cartridges with other tape drives that comply to the LTO U-316, U-416 and U-516 specification documents:

Capacity (2:1 compression)	Format	Write	Read
3000 GB (write/read)	LTO Ultrium-5	Yes	Yes
3000 GB WORM	LTO Ultrium-5	Yes	Yes
1600 GB WORM	LTO Ultrium-4	Yes	Yes
1600 GB (write/read)	LTO Ultrium-4	Yes	Yes
800 GB WORM	LTO Ultrium-3	No	Yes
800 GB (write/read)	LTO Ultrium-3	No	Yes
400 GB (write/read)	LTO Ultrium-2	No	No
200 GB (write/read)	LTO Ultrium-1	No	No
100 GB (write/read)	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 (<i>only valid when the drive is operated in a standard office environment</i>)	<i>Full-height</i> : 120,000 cycles
	<i>Half-height</i> : 80,000 cycles
Population MSBF	100,000 cycles
Head life (typical)	60,000 hours
Reposition life	1,000,000 cycles (media limited)
Lifetime of drive (5 years at 100% duty cycle)	43,800 hours
Maximum cartridge uses	20,000 threads
Cartridge Extraction Force	2.25N to 5.8N (0.5 lbf to 1.3 lbf)
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

10 Performance specification

The drive will match the throughput of any host up to the maximum supported transfer rate using the Data Rate Matching (DRM) functionality. There is no performance penalty for hosts that are slower than the maximum supported transfer rate. This capability is accomplished using buffer management for transfer rates of 0 MB/s up to the minimum tape streaming transfer rate, and the Adaptive Tape Speed (ATS) technology from the minimum to maximum tape streaming transfer rate.

Transfer rates

Maximum sustained transfer rate	<i>Native:</i>	140 MB/s
	<i>Compressed (2:1):</i>	280 MB/s
	<i>Any compression:</i>	535 MB/s
Streaming native data rate range		47–140 MB/s (LTO 5) 40–120 MB/s (LTO 4) 27–80 MB/s (LTO 3)
Burst transfer rate	<i>FC:</i>	800 MB/s
	<i>SAS:</i>	600 MB/s
Maximum block size	<i>without encryption:</i>	16 MB
	<i>with encryption:</i>	8 MB
Compression engine bandwidth		600 MB/s
Encryption engine bandwidth		600 MB/s

The drive will match the throughput of any host up to the maximum supported transfer rate using the Data Rate Matching (DRM) functionality. There is no performance penalty for hosts that are slower than the maximum supported transfer rate. This capability is accomplished using buffer management for transfer rates of 0 MB/s up to the minimum tape streaming transfer rate, and the Adaptive Tape Speed (ATS) technology from the minimum to maximum tape streaming transfer rate.

Data compression

The compression engine uses an enhanced algorithm based on ALDC where data expansion due to redundant data is minimized. 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 turn off Data Compression using the Data Compression mode page or the SDCA parameter in the Sequential Access Mode Page.

Speeds

Tape read/write speed	6.04 m/s (LTO 5) 6.20 m/s (LTO 4) 5.32 m/s (LTO 3)
Tape rewind speed	9.00 m/s

Timings

Capacity full backup times

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

Cartridge	Time
3000 GB LTO 5	3.2 hours (TBC)
1600 GB LTO 4	2.24 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 longer to load.

Access times (time to data)

		Time
Average access time from BOT to MOT	3000 GB LTO 5:	52s
	1600 GB LTO 4:	50s
	800 GB LTO 3:	42s
Maximum access time from BOT to EOT	3000 GB LTO 5:	97s
	1600 GB LTO 4:	94s
	800 GB LTO 3:	79s

Other times

Parameter	Time
Mean reposition time	2.50s (TBC)
Turn-around time at end of wrap	1.5s max.
Time to rewind EOT-BOT	Ultrium-5: 96s (TBC) Ultrium-4: 93s (TBC) Ultrium-3: 78s (TBC)
Time to rewind MOT-BOT	Ultrium-5: 47s (TBC) Ultrium-4: 46s (TBC) Ultrium-3: 38s (TBC)
Cleaning time with a cleaning cartridge	58-152s

11 Support and other resources

Related documents

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	SAS Drives
Connectors	1 HW Integration: ch. 4	1 HW Integration: ch. 7
Front panel LEDs	1 HW Integration: ch. 3	1 HW Integration: ch. 6
Specifications	4 Specifications	

Installation and configuration

	FC Drives	SAS Drives
Connectors	1 HW Integration: ch. 4	1 HW Integration: ch. 7
Determining the configuration	2 SW Integration: ch. 2	

	FC 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>
Linux configuration	5 UNIX, Linux, OpenVMS Configuration	
Modes of usage	n/a	1 HW Integration: <i>ch. 8</i>
OpenVMS configuration	5 UNIX, Linux, OpenVMS Configuration	
Optimizing performance	n/a	1 HW Integration: <i>ch. 8</i>
	2 SW Integration: <i>ch. 4</i>	
UNIX configuration	5 UNIX, Linux, OpenVMS Configuration	

Operation

	FC 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>

Cartridges

	FC 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	SAS Drives
FC, SCSI and SAS host interface guide	3 Host Interface	

	FC Drives	SAS Drives
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>	
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	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>
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	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>	

	FC Drives	SAS Drives
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	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>	
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 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

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