HP Ultrium vs. IBM Ultrium vs. Seagate Ultrium vs. HP SuperDLT

Summary - Ultrium vs. SDLT

- Transfer rate advantage (15 to 16 MB/sec vs. 11 MB/sec) for Ultrium over SDLT. Testing demonstrates this transfer rate advantage for most data sets.

- Larger native capacity media advantage for SDLT (SDLT 110 GB vs. Ultrium 100 GB). However, testing shows that the more efficient data compression engine used by Ultrium negates the larger native capacity of SDLT media and in some cases, Ultrium media has a larger useful capacity.

- All drives state reliability at 250,000 hours MTBF with a 100% duty cycle. Unlikely that the reliability winner will be seen until feedback from field available. Inspection reveals that the buckling mechanism used by SDLT, because of the requirement to read DLTIV tapes, is less rigid and appears less robust than the all the buckling mechanisms implemented on the Ultrium products.

Summary - Ultrium products

**HP Ultrium**

**strengths**
- Data rate matching – more efficient than Seagate and IBM does not have it
- Only drive with HP OBDR
- “Active” head cleaning
- FH drive and HH drive
- Family of Ultrium products

**weaknesses**
- No LCD on reseller model (neither has Seagate)
- Cannot perform diagnostic checks through front panel (as is possible on IBM Ultrium)

**IBM Ultrium**

**strengths**
- Family of Ultrium products
- Many diagnostic tests possible through front panel with LCD
- Mechanical isolation of mechanism

**weaknesses**
- Up to 50 W power requirement (double HP Ultrium) hence no internal reseller product, not compatible with many servers without additional fan pack
- Fail modes exist with bad cartridges and power loss during load
- Crude head cleaning mechanism

**Seagate Ultrium**

**strengths**
- Perception of quality through appearance of the mechanism (if covers removed)
- Mechanical isolation of mechanism

**weaknesses**
- Worst performer in tests – despite best paper spec
- No head cleaner
- Least positive manual load
Contents

Comparison of Key Published Specifications

Product Differentiation - Marketing

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More Specification Comparisons

Reseller / Branded Product details

Media Comparison

Testing Results
  Throughput - Backup and Restore
  Tape Capacities
Comparison of Key Published Specifications
All data below is taken from vendor’s published literature

<table>
<thead>
<tr>
<th>Performance</th>
<th>HP Ultrium</th>
<th>IBM Ultrium</th>
<th>Seagate Ultrium</th>
<th>SuperDLT</th>
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<tr>
<td>capacity (native)</td>
<td>100GB</td>
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<td>110GB</td>
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<td>sustained transfer rate (native)</td>
<td>15MB/sec (900MB/min) (54GB/hr)</td>
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<td>M TBF</td>
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<td>L = 325.12mm W = 175.26mm H = 160.02mm</td>
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<td>User Interface</td>
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<td>front panel (bezel)</td>
<td>4 LEDs</td>
<td>1 LED + 1 char. display (plus 40 char. LCD on desktop model)</td>
<td>4 LEDs (repositioned for desktop model)</td>
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<td>Power</td>
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<td>idle (tape loaded)</td>
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<td>8.5W</td>
<td>17W internal</td>
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<td>maximum</td>
<td>41W</td>
<td>5V @ 5A 12V @ 2.5A</td>
<td>27W</td>
<td>43W internal 46W desktop</td>
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Product Differentiation - Marketing
What the 4 vendors highlighted in their product literature to differentiate their products.

**HP Ultrium**
- Data Rate Matching with Adaptive Tape Speed
- HP O BDR
- TapeTools II support ensures correct installation and provides diagnostic support
- Family of Ultrium products including a HH product

**IBM Ultrium**
- Surface Control Guiding System to handle media
- “Dynamic Buffer for best drive performance”
- SARS (Statistical Analysis and Reporting System) for drive and media fault reporting
- Family of Ultrium products
- Leverages proven technology from HDD and Magstar products (read/write equalization, data flow management, data channel, SCSI circuitry) and HDD manufacturing processes

**Seagate Ultrium**
- Patents on design (Dynamic Powerdown System, FastSense™ Technology, Head Positioning System, Tape Threading System)
- Dynamic Powerdown keeps media safe in a power cut
- FastSense™ Technology maintains performance when host has a data rate below drive streaming rate.
- 64 MB cache
- Managed airflow (two fans)
- Reseller products bundled with Backup Exec

**SuperDLT**
- Read compatibility with DLTIVtape (DLT8000, DLT7000, DLT4000) media
- Positive Leader Link - “robust buckling mechanism to overcome lost leader problems with DLT drives”.
- 220 GB cartridge capacity (with 2:1 compression)

**Notes**
A feature similar to the Dynamic Powerdown feature of the Seagate drive is also implemented in HP Ultrium. The HP drives also store power and stop safe in the event of an unplanned power termination.

The HP Ultrium and Seagate Ultrium drives have variable speed mechanisms. The IBM Ultrium and SDLT do not. Of these variable tape speeds, HP Ultrium is the most effective implementation. The main difference is that HP Ultrium’s Data Rate Matching feature operates on the fly, while Seagate Ultrium’s FastSense feature only adjusts tape speed at the end of a wrap and also in steps.

HP Ultrium (TapeTools II), IBM Ultrium (SARS) and SDLT (DLTtools) all have diagnostic programs to support users. Seatools, Seagate’s program is not available for tape yet.
Product Comparisons

1 Mechanical Design

**HP Ultrium**
- Mechanism made by Philips.
- Single stage head position actuator
- Plastic take-up reel
- Data rate matching feature reduces tape repositioning for increased reliability through reduced stress on mechanism and media.

**IBM Ultrium**
- Mechanism made by NEC
- Mechanism isolated by 4 dampers – to compensate for lack of low frequency gain in servo system?
- Vibration (or is it a position sensor?) incorporated between reels →
- Metal drive clutch for cartridge
- Polycarbonate carbon fibre composite reels for tape (very expensive tooling)

**Seagate Ultrium**
- Mechanism made by Seagate
- Mechanism mounted onto chassis via isolating dampers.
- Thermal and electrical separation between recording system and electronics
- Two stage head position actuator
- Metal drive clutch for cartridge
- Cast and machined aluminium take up reel

**SuperDLT**
- Comprised of two ‘modules’
  - TCM – tape control module (base plate, cartridge receiver, buckling mechanism and a PCB)
  - DCM – data control module (read-write head, head servo mechanics, take up reel, tape guides).
- Separate PCA to control tape loading and buckling

**Notes**

IBM and Seagate Ultrium drives have a metal drive clutch for cartridge – possible debris creation. HP Ultrium uses a plastic drive clutch.

Each drive reposition increases the probability of the mechanism failing. The HP Ultrium ATS reduces the number of repositions required and consequently increases reliability.

Both the Seagate and IBM are isolated from the chassis of the drive to reduce transmitted vibrations. Unlikely to be any benefit in this except in extreme operating conditions. In these high vibration conditions the HP drive will slow down.
2 Cartridge Loading and Media Threading

**HP Ultrium**

- “Soft load” with mechanical assist
- 4 check states ensure that threading commences only when the leader pin is properly captured in the leader block
- Threading positively locks leader pin in leader block so the leader pin won’t be lost if power is lost
- Leader block is in the shape of a half-moon, matched cutout in the hub of the take-up reel forms a cylindrical winding surface

**IBM Ultrium**

- "soft load" with mechanical assist
- If cartridge does not load in drive properly the mechanism forces the cartridge out again before retrying the load.
  - not allowed in Ultrium format
  - not acceptable in a library
- “juggles” leader pin into slot – not as accurate as HP Ultrium leader capture
- Fail modes will be encountered during threading, means drives must be returned to IBM:
  - liable to lose leader block if power lost during threading
  - no sensors to detect if leader pin present, if cartridge has no leader pin, mechanism pulls threader into the drive and cannot recover
- Poor tape tension control during threading - slack tape evident
- As an option a Leader Pin Reattachment kit (p/n 08L9129) is available.

**Seagate Ultrium**

- “Soft load” with mechanical assist
- Manual load does not accommodate non-straight offering of the cartridge. Cause is the basic side gripping mechanism for cartridge lugs. HP mechanisms have a more sophisticated and positive engagement and grabbing mechanism.
- Roller bearings used on all sliding mechanisms
- Patent pending for threading system. Mechanical arm facilitates multiple retries to engage leader pin.
- Positive Leader Link – describes solid, metal pin attached to drive leader
  - compatible with SDLT media and DLTIVtape
- 2 optical sensors on tape path to feedback threading information
  - pin location in cartridge
  - slot location in take up reel
- Take up reel tensions cartridge reel during threading

**SuperDLT**

- “soft load” with mechanical assist
- Leader capture mechanism design constrained by requirement to load DLTIVtape cartridges and SDLT cartridges. Not as rigid or positive as any of the Ultrium buckling mechanisms.
Notes

The HP Ultrium drive has a major advantage against IBM and to a lesser extent against the Seagate drive in media threading system. IBM Ultrium has some fail modes that will require users to return drives to IBM for repair.

IBM Ultrium can lose the leader block if power is lost during threading and there is the slightest amount of shaking. The HP Ultrium uses two mechanisms to ensure power loss during threading is not a problem: 1) A snapping feature that holds the leader pin firmly in the leader block so it cannot be disconnected if power is lost. 2) The threading track holds the leader block in the proper position if power is lost. The HP Ultrium design team anticipated this fail mode and designed it out.

Another fail mode the IBM Ultrium is susceptible to is when a cartridge is loaded without a leader pin. The IBM Ultrium does not have any sensors to detect the presence of the leader pin. If it is missing, or out of place within the cartridge, the threading mechanism attempts to thread and pulls the threader into the drive and cannot recover. Even though it uses a driven mechanism for threading, there is no retry capability. Once the threader is moved toward the T-reel, it cannot be returned without pulling it back with the cartridge leader. The HP Ultrium implementation uses sensors on both ends of the leader pin to ensure proper engagement before attempting to thread.

There is anecdotal evidence from STK and ADIC that other media defects, such as failed CM, also cannot be handled by IBM Ultrium. Seagate Ultrium also suffers the danger of decoupling from the leader pin if power is lost during a threading operation. There is no means other than back tension from the cartridge reel to maintain the connection.

For manual cartridge load the HP mechanism is the smoothest, closely matched by the IBM mechanism. The HP mechanism is also tolerant of cartridges not offered up exactly perpendicular to the mechanism. By contrast the Seagate mechanism is not accommodating of cartridges offered up not perfectly square. It also feels non-positive.
3 Tape Path and Tape Control

**HP Ultrium**
- 2 rotating guide rollers
- Data Rate matching by an adaptive tape speed (ATS) algorithm
  - adapts to changing host data rates on the fly
  - range is 6 MB/sec to 15 MB/sec (2.1 to 4.1 m/sec)

**IBM Ultrium**
- Surface Control Guiding - patent pending
  - name used to distinguish this from ‘edge guiding’
- 4 guide rollers
  - 2 (nearest head) with decompression grooves
  - 2 without grooves

**Seagate Ultrium**
- 2 fixed “D” edge guides and 2 rollers on tape path
- made of Fe-doped zirconia - conductive
- “stiction” problems with stationary guides
- fixed guides wear faster than rotating guides
- FastSense™ technology adjust tape speed to host data rate
  - operates in steps: 8, 10, 12, 14 or 16 MB/sec (2.1, 2.6, 3.1, 3.6 or 4.2 m/sec)
  - tape speed only changes at the end of a wrap - could be 10 minutes with a slow host and compressible data

**SuperDLT**
- no variable tape speed but adjusts data buffer level based on average data transfer rate sensed on SCSI bus

**Notes**
4 Electrical and Servo System

**HP Ultrium**

- highest number of discrete components on PCB
- all electronics on a single board
- high number of connections to main PCB (11)
- 5 motors
- IBM timing based track following servo

**IBM Ultrium**

- highest number of discrete components on PCB
- all electronics on a single board
- high number of connections to main PCB (11)
- 5 motors
- IBM timing based track following servo

**Seagate Ultrium**

- 8 layer PCB, all signals on inner layers
- 2 major ASICs
  - "Whirlpool" – servo control
    - ARM 7TDN I embedded 32-bit RISC processor
  - “Scrambler” – formatter
    - ARM 7TDN I embedded 32-bit RISC processor
- 7 motors
  - 2 x reel motors – 3 phase brushless, 10 poles
  - 2 x load motors – brush motor
  - 1 x head coarse position – stepper motor
  - 1 x head fine position – linear voice coil
  - 1 x tape thread
- “Dynamic Powerdown System” stores 2 seconds of power to protect media in the event of an unplanned power cut
  - stored power brakes take up reel and cartridge reel
  - servo technology maintains tape tension
- Active electrical system between PCB and chassis to reduce emissions. What is this?

**SuperDLT**

- desktop version is auto-ranging
  - 100V to 220V
  - 47Hz to 63Hz
- desktop version power supply rated at 65W
Notes

HP Ultrium

IBM Ultrium

Seagate Ultrium

SuperDLT
5 Read-Write Head

HP Ultrium

- multi-channel inductive write/ M R. read shared pole head technology
  - chosen for high data rate, speed-independent signal-to-noise, and high areal density.
- recording head was developed jointly with Seagate and is sourced from Seagate
  - leverages expertise in M R. technology and thin film, assembly and manufacturing expertise
  - reduces cost by higher production volumes and shared development costs
- 2-array head design is used for read while write

IBM Ultrium

- Produce heads “themselves” (IBM Magnetorestive Head Division).

Seagate Ultrium

- Produce head “themselves” (Seagate Recording Head Operations).
  - Two stage (coarse + fine) head position actuator
    - fine positioning uses a voice coil
  - 4 read-write pre-amps (see diagram)

SuperDLT

- Head from ReadRite corporation
- A second (read) head stack to provide read compatibility with DLTIVtape
- This backward read compatibility head retracts during cartridge load/unload and non-backward operation to reduce head wear and contamination build up.

Notes

Multichannel M R. heads have been used by IBM, STK, and Fujitsu in linear tape drives for more than five years, so there is a substantial wealth of industrial experience with this technology.
6 Thermal Management

**HP Ultrium**
- mechanical and electrical systems designed for low power consumption

**IBM Ultrium**
- PCB has many discrete components - high heat generation
- measures to reduce heat build up include a thermal conducting strip on PCB

**Seagate Ultrium**
- Fans incorporated into 'brick'.
  - not user serviceable
  - operate as needed
  - optional for automation units
- Thermal isolation between recording head and main electronics
- thermal coupling rails between PCB edges and chassis
- read-write head isolated from airflow

**SuperDLT**

*notes*

The HP Ultrium mechanical and electrical systems design for low power consumption is validated by the ability to produce Ultrium 215.
7 User, Automation and Diagnostic Interfaces

**HP Ultrium**
- mechanism has 4 LEDs
  - ready / activity
  - drive error
  - tape error
  - cleaning required
- unload button on front
- power switch on front (desktop model)
- Automation control interface based on R-422 port
- TapeAlert utility in drives

**IBM Ultrium**
- mechanism (IBM 3580) has: single digit LED (green/amber) and single status light
- desktop / reseller model has additionally: LCD (20 characters x 2 rows)
- 8 way option switch
- unload button on front
- power switch on rear (desktop model)
- implemented TapeAlert
- manual removal of cartridge possible using screw driver access through bevel and access hole on base of mechanism
- Firmware can be revised by:
  - tape (Field Firmware Replace Tape)
  - SCSI download

**Seagate Ultrium**
- mechanism has 4 LEDs (see figure)
- desktop bezel has same 4 LEDs 'artistically' arranged (see figure)
- unload button on front
- SeaTools (does this exist?)
- RS-422 library interface
  - 2mm-centers headers at back of drive
  - commands in encapsulated SCSI protocol or Low Overhead protocol (less functionality)
- RS-232 diagnostics interface
- supports TapeAlert
- No manual cartridge unload capability
  - can rewind the tape
  - cannot “ungrab” the leader pin.
SuperDLT

- mechanism has 3 LEDs
  - cartridge write protection (on / off)
  - drive status (on / off / flashing)
  - reserved
- infra-red diagnostics port on front panel - GSLink™
  - with necessary software on a local PC, allows remote or local diagnostics and repair of drive issues
  - interface for firmware revisions control and detail
- unload button on front
- power switch on rear (desktop model)
- DLTools
- implemented TapeAlert

Notes
**Cleaning**

**HP Ultrium**

- Head cleaning strategy is smart - not just cleaning at each load/unload:
  - After each 150,000 tape pulling meters (about 5 full 100/200GB data cartridges), head cleaning takes place during the unload cycle
  - Head cleaner activated when the drive senses there might be a problem caused by contamination of the head
    - If using the head cleaner does not correct the problem then the user will be asked to insert a cleaning cartridge
  - Head cleaner is activated after cleaning cartridge has been used
  - To preserve head, a maximum of 2 weeks must elapse between use of cleaning cartridge.
  - Note: if a cleaning cartridge is inserted less than two weeks since last use of cleaning cartridge then the cleaning tape is not pulled past the head, but the (non-abrasive) head cleaner is activated.
  - Head cleaner operated by a dedicated motor
  - Brush moves perpendicularly over head
  - Head positioning actuator moves the head up and down to remove debris from grooves in head stack

**IBM Ultrium**

- Head cleaner is on a large arm. Position in picture below is with tape unloaded. Operates (passes over head) when tape is loaded. With tape loaded, the arm is stored horizontal.
  - Head cleaner brush can only make one swipe across the head during a load and unload
  - Its mechanically linked to the load/unload process
  - “C” displayed on single digit LED indicates that the drive needs to cleaned with a cleaning cartridge
  - If a cleaning cartridge is loaded when the drive is not indicating this is needed then it is ejected
  - Cleaning cartridge rated at 50 “cleans”

**Seagate Ultrium**

- No head cleaner.
- Appears to have been dropped to get product to market.
  - Head cleaner seen on early presentations of Seagate LTO
Notes

The HP Ultrium has the most efficient head cleaner implementation. The other LTO drives really rely on the cleaning cartridge for keeping the head clean. A cleaning cartridge is not nearly as effective as a brush at dislodging debris from grooves in the head assembly.

This IBM head cleaner brush is located on a large arm that is operated as part of the cartridge load or unload process. It, thus, just makes one swipe across the head during the load or unload process. This is very rudimentary and this cleaning strategy takes no account of the cleaning requirement.

HP's "active" head cleaning strategy makes the head cleaner operate when it is detected that head cleaning is needed. To facilitate this, the mechanism is designed to allow cleaning without unloading the cartridge. And, since cleaning is decoupled from the load or unload operation, the brush can operate as many times as necessary.

A further advantage of the HP implementation of the head cleaner is that it operates both down and across the grooves in the head. The IBM Ultrium head cleaner only operates down the grooves and is thus less efficient in removing any debris.

The Seagate drive has no head cleaner.
## More Specification Comparisons

Data below is taken from vendor’s published literature and other sources.

<table>
<thead>
<tr>
<th></th>
<th>HP Ultrium</th>
<th>IBM Ultrium</th>
<th>Seagate Ultrium</th>
<th>SuperDLT</th>
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<td><strong>Tape Speed</strong></td>
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<td>(1) 76sec (average) 152sec (max)</td>
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<td></td>
<td>On demand using only HP cleaning cartridge (C7979A)</td>
<td>Use IBM head cleaning cartridge</td>
<td>Cleaning cartridge</td>
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<td>auto termination on external drives</td>
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<td>SCSI ID Setting</td>
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<td>H = 82.55mm</td>
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</tr>
<tr>
<td><strong>external drive</strong></td>
<td>L = 298 mm</td>
<td>L = 211mm</td>
<td>L = 325.12mm</td>
<td></td>
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<tr>
<td></td>
<td>W = 208mm</td>
<td>W = 149.23mm</td>
<td>W = 175.26mm</td>
<td></td>
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<tr>
<td></td>
<td>H = 117mm</td>
<td>H = 86.3mm</td>
<td>H = 160.02mm</td>
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<tr>
<td><strong>Data Buffer</strong></td>
<td>cache buffer</td>
<td>16 MB</td>
<td>64 MB</td>
<td></td>
</tr>
<tr>
<td><strong>Power-ext</strong></td>
<td>auto ranging</td>
<td></td>
<td>100V to 240V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>range</td>
<td></td>
<td>and 47Hz to 63Hz</td>
<td></td>
</tr>
<tr>
<td><strong>max power</strong></td>
<td></td>
<td>25.0W</td>
<td>45W (5)</td>
<td></td>
</tr>
<tr>
<td>unloaded</td>
<td></td>
<td>24W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>standby</td>
<td></td>
<td>14.0W</td>
<td>26W</td>
<td></td>
</tr>
<tr>
<td><strong>Power-int</strong></td>
<td>max power</td>
<td></td>
<td>43W (4)</td>
<td></td>
</tr>
<tr>
<td>unloaded</td>
<td></td>
<td>16W (4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>standby</td>
<td></td>
<td>17W (4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cooling</strong></td>
<td>required airflow</td>
<td>0.17m³ per minute (6 cu ft/min)</td>
<td>125 linear feet / minute (measured in front of bezel)</td>
<td></td>
</tr>
<tr>
<td><strong>Format</strong></td>
<td>recording format</td>
<td>Linear Tape Open</td>
<td>Linear Tape Open</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ultrium-1</td>
<td>Ultrium-1</td>
<td></td>
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<tr>
<td>data compression</td>
<td>ALDC</td>
<td>ALDC</td>
<td>ALDC</td>
<td></td>
</tr>
<tr>
<td>data encoding method</td>
<td>1,7 RLL</td>
<td></td>
<td>PRM L</td>
<td></td>
</tr>
<tr>
<td>media capacities (native)</td>
<td>10, 30, 50 and 100 GB</td>
<td>10, 30, 50 and 100 GB</td>
<td>10, 30, 50 and 100 GB</td>
<td></td>
</tr>
<tr>
<td>Cartridge Memory</td>
<td>yes – part of Ultrium format</td>
<td>yes – part of Ultrium format</td>
<td>yes – part of Ultrium format</td>
<td></td>
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<tr>
<td>Tape path</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td><strong>Diagnostics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Self-test and HP Library &amp; TapeTools test suite</td>
<td>Self-test</td>
<td></td>
<td></td>
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<tr>
<td><strong>Firmware</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Revision E09D - upgrade via tape or SCSI bus</td>
<td>Upgrade via tape or SCSI bus</td>
<td></td>
<td></td>
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<tr>
<td>Operational</td>
<td>HP SureStore Ultrium 230</td>
<td>IBM</td>
<td>Seagate Viper 200</td>
<td>HP SureStore SuperDLT 220</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------------</td>
<td>-----</td>
<td>-------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>dry bulb temperature range</td>
<td>10° to 35°C</td>
<td>10 - 38°C</td>
<td>10° to 40°C (50°F to 104°F)</td>
<td>10° to 40°C (50°F to 104°F)</td>
</tr>
<tr>
<td>relative humidity (non-condensing)</td>
<td>20 - 80%</td>
<td>20 - 80%</td>
<td>80% max</td>
<td>20% to 80%</td>
</tr>
<tr>
<td>max wet bulb temperature</td>
<td>26°C</td>
<td></td>
<td>25°C (77°F)</td>
<td></td>
</tr>
<tr>
<td>altitude</td>
<td>0km to 4km</td>
<td>&lt;2,500m</td>
<td></td>
<td>-0.15km to 9.1km (500ft to 30,000ft)</td>
</tr>
<tr>
<td>required cooling airflow</td>
<td>0.17m³ per minute (6cu ft/ min)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>suspended particles</td>
<td>&lt;200µg/ m³</td>
<td></td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Storage / Shipping⁽³⁾</th>
<th>HP SureStore Ultrium 230</th>
<th>IBM</th>
<th>Seagate Viper 200</th>
<th>HP SureStore SuperDLT 220</th>
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</thead>
<tbody>
<tr>
<td>dry bulb temperature range</td>
<td>-40° to 66°C</td>
<td>-40° to 60°C (40°F to 140°F)</td>
<td>-40° to 66°C</td>
<td>-40° to 66°C (40°F to 150°F)</td>
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<tr>
<td>relative humidity (non-condensing)</td>
<td>10% to 95%</td>
<td>10% to 90%</td>
<td>95% max</td>
<td>10% to 95%</td>
</tr>
<tr>
<td>max wet bulb temperature</td>
<td>non-condensing</td>
<td></td>
<td>46°C (114°F)</td>
<td></td>
</tr>
<tr>
<td>altitude</td>
<td>0km to 15.25km</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes**

1. IBM POST tales ~90 secs
2. Dimensions are without the bezel.
3. Dry bulb temperature is simply the surrounding ambient air temperature without any air motion.
   Wet bulb temperature is the temperature air would have if its energy were used to evaporate an amount of water equal to the amount of water vapor it contains.
4. Internal power supply on SDLT is rated at 65W
## Reseller Product Details

<table>
<thead>
<tr>
<th></th>
<th>HP SureStore Ultrium 230e</th>
<th>IBM StorageSmart Ultrium TX200, T200</th>
<th>Seagate Viper 200</th>
<th>HP SureStore SuperDLT 220</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standard Warranty</strong></td>
<td>3 years Express Exchange. System matching warranty when purchased with an HP Netserver.</td>
<td>3 year mail-in exchange</td>
<td>3 years REACT programme in Europe and N America</td>
<td>3 years Express Exchange. System matching warranty when purchased with an HP Netserver.</td>
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<tr>
<td><strong>Product Numbers</strong></td>
<td></td>
<td></td>
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<tr>
<td>internal drive</td>
<td>C7400A</td>
<td>IBM 3580 T200</td>
<td>STU42001LW-K (LVD, bundled(^{(i)}))</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>STU42001LW-S (LVD)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>STU42001W D-S (HVD)</td>
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<tr>
<td>external drive</td>
<td>C7401A</td>
<td>IBM 3580 TX200</td>
<td>STU62001LW-K (LVD, bundled(^{(i)}))</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>STU62001LW-S (HVD)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>STU62001W D-S (HVD)</td>
<td></td>
</tr>
<tr>
<td>Rackmount drive</td>
<td>C7470A</td>
<td>N/A</td>
<td></td>
<td></td>
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<td><strong>Interfaces</strong></td>
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<td></td>
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<tr>
<td>SCSI II</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>LVD, HVD</td>
<td></td>
</tr>
<tr>
<td><strong>Pricing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>desktop model</td>
<td>$5,505(^{(a)})</td>
<td>$8,325(^{(c)})</td>
<td>$6,139(^{(d)}) bare $6,279(^{(d)}) bundle</td>
<td></td>
</tr>
<tr>
<td>internal model</td>
<td>$5,325(^{(b)})</td>
<td></td>
<td>$5,805(^{(e)}) bare $5,939(^{(e)}) bundle</td>
<td></td>
</tr>
</tbody>
</table>

(b) hp.com - business store, 12 Jan 2001, excludes shipping, taxes and accessories. BoM = CD-ROM (containing TapeAlert, Tape Tools and drivers), manual, rails, data cartridge and cleaning tape.
(c) from shopIBM, 12 January 2001, excludes shipping and taxes. BoM = 2.5m SCSI cable and required drivers
(d) suggested selling price, seagate.com 12 January 2001
(e) seagate.com, 12 Jan 2001 BoM for bundle = data cartridge, cleaning cartridge and VERITAS Backup Exec (single server edition)
## Media Comparison

<table>
<thead>
<tr>
<th></th>
<th>Ultrium</th>
<th>SuperDLT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>type</strong></td>
<td>Metal particle PEN</td>
<td>Advanced Metal Powder (AMP)</td>
</tr>
<tr>
<td><strong>Dimensions, Color, Weight</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cartridge width</td>
<td><strong>W = 105.4 mm</strong></td>
<td><strong>W = 104.1 mm (4.1&quot;)</strong></td>
</tr>
<tr>
<td></td>
<td><strong>L = 102.0 mm</strong></td>
<td><strong>L = 104.1 mm (4.1&quot;)</strong></td>
</tr>
<tr>
<td></td>
<td><strong>H = 21.5 mm</strong></td>
<td><strong>H = 25.4 mm (1&quot;)</strong></td>
</tr>
<tr>
<td>color</td>
<td>HP = blue (pantone 287C)</td>
<td>dark green</td>
</tr>
<tr>
<td></td>
<td>IBM = black</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Seagate =</td>
<td></td>
</tr>
<tr>
<td>weight (longest tape)</td>
<td>0.2 Kg</td>
<td>0.21 Kg</td>
</tr>
<tr>
<td><strong>Tape Features</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tape length (longest tape)</td>
<td><strong>609 m ± 1m</strong></td>
<td><strong>549m (1,800')</strong></td>
</tr>
<tr>
<td>tape width</td>
<td><strong>12.65 mm (½&quot;)</strong></td>
<td><strong>12.65 mm (½&quot;)</strong></td>
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<tr>
<td>data tracks</td>
<td>384</td>
<td>448</td>
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<tr>
<td>track density</td>
<td>35.3 tracks/ mm (896 tpi)</td>
<td></td>
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<tr>
<td>linear bit density</td>
<td>133 kbits/ inch</td>
<td></td>
</tr>
<tr>
<td>coercivity</td>
<td>1850 oersteds</td>
<td>1850 oersteds</td>
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<tr>
<td>tape thickness</td>
<td>8.9 microns</td>
<td>8.9 microns</td>
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<tr>
<td>recording density</td>
<td>4.88 Kbit/ mm</td>
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<tr>
<td>media life</td>
<td>1,000,000 passes</td>
<td>1,000,000 passes</td>
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<tr>
<td><strong>Media Storage</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>maximum dry bulb temperature</td>
<td><strong>16°C to 32°C</strong></td>
<td><strong>18°C to 28°C (with data)</strong></td>
</tr>
<tr>
<td></td>
<td><strong>16°C to 32°C (no data)</strong></td>
<td><strong>18°C to 32°C (no data)</strong></td>
</tr>
<tr>
<td>relative humidity (non-condensing)</td>
<td><strong>20% to 80%</strong></td>
<td><strong>40% to 60% (with data)</strong></td>
</tr>
<tr>
<td></td>
<td><strong>20% to 80% (no data)</strong></td>
<td><strong>20% to 80% (no data)</strong></td>
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<tr>
<td>media archive life</td>
<td>30yrs</td>
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<tr>
<td><strong>Products Available</strong></td>
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<tr>
<td>native capacities</td>
<td>100GB, 50GB, 30GB, 10GB</td>
<td>110GB</td>
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<tr>
<td>1 piece media -</td>
<td>HP - C7971A</td>
<td>IBM - O8L9120</td>
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<td>100GB(native)</td>
<td>IBM - O8L9120</td>
<td>Seagate - STUM 200</td>
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<tr>
<td>cleaning cartridge</td>
<td>HP - C7979A</td>
<td>IBM - O8L9124</td>
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</tbody>
</table>
Testing Results

1 Cartridge Capacity

This test scheduled a backup of ~1GB to run until the backup software reported that the cartridge was full. In reality this test measures the efficiency of the data compression algorithms employed by the two drives. The test was run with three different data sets.

data set #1: pre-compressed data
data set #2: typical user data
data set #3: highly compressible data

Results:

<table>
<thead>
<tr>
<th>data set</th>
<th>SDLT</th>
<th>HP Ultrium</th>
<th>SDLT</th>
<th>HP Ultrium</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>data on full tape</td>
<td>compression ratio</td>
<td>data on full tape</td>
<td>compression ratio</td>
</tr>
<tr>
<td>1</td>
<td>96.8GB</td>
<td>0.88</td>
<td>99.8GB</td>
<td>0.99</td>
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<tr>
<td>2</td>
<td>169.5GB</td>
<td>1.54</td>
<td>167.5GB</td>
<td>1.67</td>
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<tr>
<td>3</td>
<td>356.6GB</td>
<td>3.24</td>
<td>365.4</td>
<td>3.65</td>
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<tr>
<td>spec. sheet</td>
<td>220GB</td>
<td>2</td>
<td>200GB</td>
<td>2</td>
</tr>
</tbody>
</table>

tests performed at HP(Bristol) 11 - 16 Jan 2001

Notes

The results from data set 1 validate the effectiveness of the pass-thru mode the Ultrium compression engine uses to deal with pre-compressed or incompressible data

The results from data set 2 and 3 show the superior efficiency of the compression engine used by Ultrium (based on the ALDC algorithm) compared to the DLZ compression algorithm used in SDLT.
2 Power Requirement

An incomplete set of results was acquired. Testing measured current on the 5V and 12V power lines going into the drives. Triffid was used send read, write and tape movement commands to the Ultrium drives. It was attempted to use DLTtools to send commands the SDLT drive.

**HP Ultrium** Results shown below. Maximum power requirement during writing.

![Graph showing power requirements](image)

**IBM Ultrium** Our power supply was not able to supply enough current tp get the drive through the POST. More than 4A (limit of the power supply) was needed on the 5V line.

**Seagate Ultrium** Was not working (our fault).

**SDLT** We couldn't get DLTtools to drive the SDLT.

**Notes**

The IBM drive is very power hungry. Taking the maximum rated power (5V *5A + 12V * 2.5A) of 50W is significantly more than HP Ultrium. Adding to this the power required for the optional fan pack will preclude the installation of this drive into many low- and mid-range servers.
3 Throughput Tests

Testing was done using an HP NetServer LH6000 as the host (2 x 550 MHz Xeon processors, 256 MB RAM, 8 x 9.1 GB, Ultra SCSI II, 7,200 rpm disks housed in a dual channel backplane connected via HP NETRAID 4M, 233 MHz, 128 MB cache controller). The tape drives were directly connected via an Adaptec Ultra 160 SCSI III PCI to SCSI adapter.

OS was Windows 2000 (sp1) and backup application was CA ARCserve 2000.

10 data sets were used for backup tests. 6 of these were also used for restore tests.

A - 1MB, non-specific (random content) file type, flat file structure
B - 10MB, non-specific (random content) file type, flat file structure
C - various sized bitmaps, flat file structure
D - 1MB Zipped (compressed 100 MB) files, flat file structure
E - 10MB Zipped (compressed 100 MB) files, flat file structure
F - combination of D & E
G - various sized files from HP (Bristol) files server (MS Office, Outlook .pst, jpegs, etc), deep directory structure
H - various sized video (.avi) files, flat file structure
I - MS Exchange database
J - MS Access databases (.mdf)

Backup Rates
Notes

Overall the HP Ultrium drive is the backup performance winner. The IBM Ultrium is the closest challenger. Although the Seagate Ultrium has the highest ‘paper’ throughput it is the slowest Ultrium product in backup tests and in some cases slower than the SDLT. The SDLT versus the average of the three Ultrium drives is not as far behind as the ‘paper’ specification would suggest. The HP Ultrium drive (15 MB/sec) does show a differential compared to SDLT (11 MB/sec) that validates the differential ‘paper’ specification.

For restore rates, all the Ultrium drives are faster than SDLT. Overall the HP, IBM and Seagate drives all have similar restore performance.