



HP Ultrium Cleaning Strategy



white paper

HP ensures LTO has an effective cleaning strategy

Abstract

This white paper explains how HP develops a highly effective cleaning strategy for the new generation of high-performance HP Ultrium tape products. It describes the preventative and corrective cleaning regimes that enable the drive to deliver its outstanding reliability.

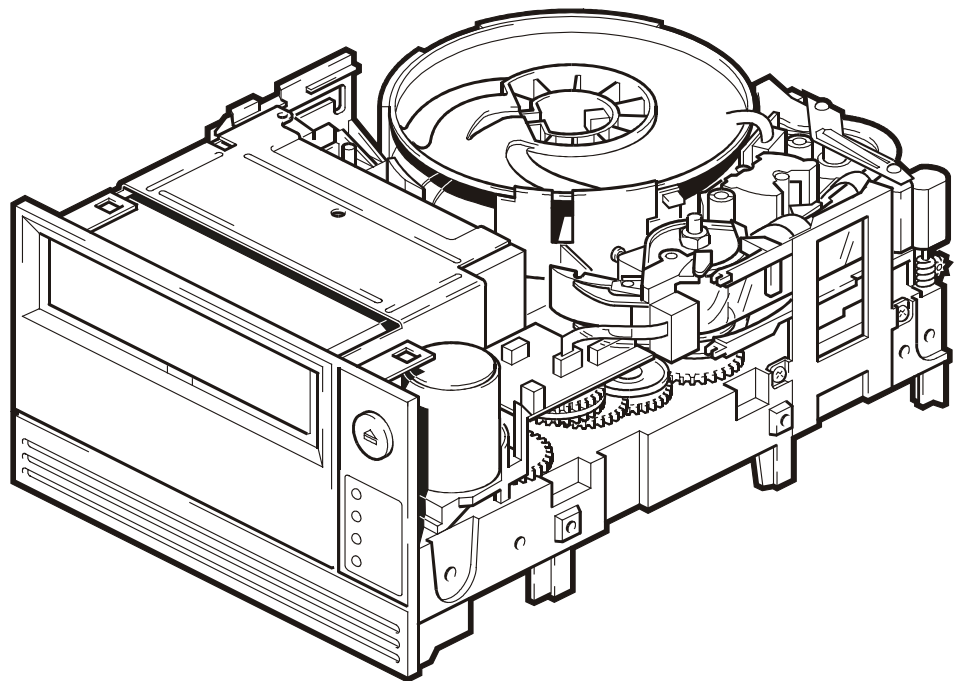


Figure 1: HP LTO tape drive

How to use this white paper

This white paper describes the reason that cleaning is required for a tape drive, differences due to technology, various components working in unison to ensure optimal cleaning strategy, the cleaning algorithm, the role of cartridge memory and the behavior of drive's firmware. It also includes a Q&A section on most commonly asked questions regarding cleaning cartridge.

Contents

The HP Ultrium tape drive is a new, high performance tape drive that requires less frequent cleaning. HP long term reliability testing has proven that regular preventative cleaning is not necessary on HP Ultrium tape drive even after 6,000 hours continuous runtime

The main topics in this white paper are:

- Why do you need to clean a tape drive?
- Why LTO technology is different?
- Preventative cleaning using the Internal Head Cleaner
- How effective is the Internal Head Cleaner?
- Corrective cleaning using the Cleaning Cartridge
- What is the impact of multiple cleaning operation?
- HP Cleaning Algorithm
- Duration of a cleaning cycle
- Role of Cartridge Memory (LTO-CM)
- Prevention against non-approved cleaning
- Universal cleaning cartridge
- Firmware Behavior
- FAQ

Executive Summary

A new generation of tape drives has been developed that can back up higher capacities of data in a shorter amount of time and it requires very little cleaning after an extended period of use. The new tape technology is the Linear Tape Open (LTO). The HP Ultrium represents one of the new breeds of tape drives that is setting a new paradigm in tape backup.

Why do you need to clean a tape drive?

For optimum recording characteristics the recording element of a tape drive must be very close to the media during operation. The tape tension is carefully controlled within a tight tolerance in order to maintain this head/media separation*. The head/tape interface is normally air-cushioned when the tape is flying over the head, however, some initial frictional contact is inevitable and this is known as the burnishing effect. As the media surface wears with increasing number of passes, media debris is generated.

Excessive debris or other material may accumulate on the head/tape interface if the drive is used with non-approved media or operated in a hot, humid and dusty environment. Such debris at the recording head/tape interface is commonly known as a head clog, which degrades write/read performance due to increase in head/media separation or spacing loss. The head clog may result in errors that exceed the error correction capability of the drive.

In this case, the drive would report a tape error and/or flashes the Use Cleaning Cartridge LED. This means that the drive head needs to be cleaned. In nearly all cases of head clog, cleaning has proven to improve the drive performance.

IMPORTANT: It is essential to use only Ultrium cleaning cartridges with Ultrium tape drives as other format cleaning cartridges will not load and run.

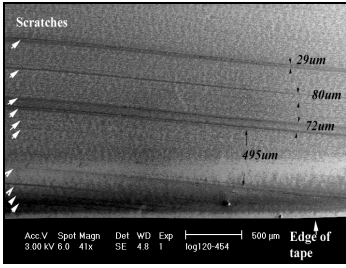
Tape Bearing Surface

Recording Elements

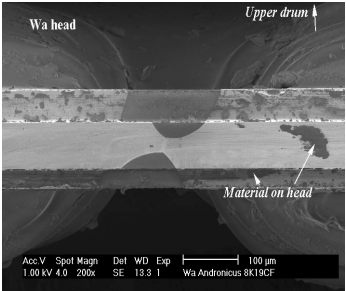


Media debris on tape bearing surface after completion of the one million pass testing.

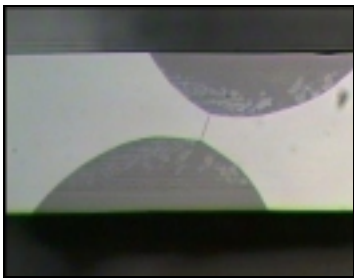
* For MR heads some level of protection against ESD is required due to this close proximity of head and media. No current is applied to the head when the tape speed is below the minimum recording speed.



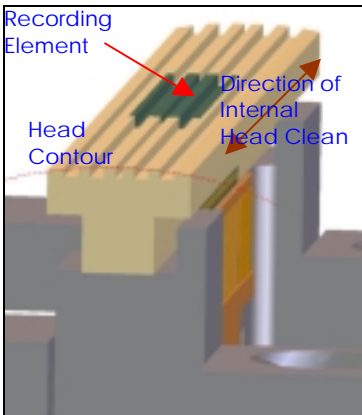
Helical scratch pattern created by severe head clogs.



Media debris on a DDS write head.



Staining formation on DDS read head.



Slotted Head Contour of a HP Ultrium tape drive

Why LTO technology is different?

Based on HP's experience as a leading tape drive manufacturer, there are three types of head contamination. These have been defined as follows:

- **Clog:** Loose debris which can cause temporary spacing loss at the head tape interface. Material can easily be removed.
- **Stain:** Transfer of external material, usually from the media, forming a highly adherent film, usually on the head. The result is loss of performance due to spacing loss.
- **Smear:** Transfer of pole tip, shield, and /or MR stripe material across the head gap causing degraded performance or magnetic shorting.

In the DDS technology most foreign material that forms head contamination comes from media. Formation of a head clog has been seen and in severe cases can lead to helical scratching of the media surface. "Trenches" resulting from a single helical scratch are responsible for further undesired cushioning of the head away from the tape, thus increasing the spacing loss. Head clogs not only degrade the performance of the drive but also can permanently damage the recording media. Such physical damage may, in extreme circumstances, lead to data loss.

Staining is a result of the frictional tribology phenomena between the head and media material. The stain formation has been found under low humidity operating condition and the amount of stain correlates with the performance degradation seen as error rate drift. After extensive sustained low humidity testing, minimal staining has been observed on the recording elements in the HP Ultrium drive. The head and media are designed to prevent staining.

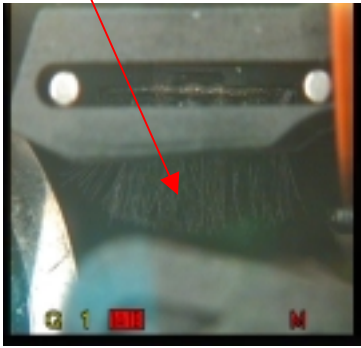
In the Travan technology some level of staining is expected in the recessed pole tip region. Pronounced stains tend to form at the MR read transducer, possibly due to thermal effects. The amount of staining depends on the abrasivity of the recording media. With fresh tape, the abrasivity is high enough to prevent stains from forming. As the tape wears, the abrasivity is reduced and staining begins to occur. If the stains become severe enough to substantially increase head/tape interface, the recording performance will degrade, leading to an increase in error rate and possible failure of drive to write and read.

Smearing was observed to a lesser degree in the early prototypes of LTO drive. It was found that lowering the electrical potential difference between the MR element and its shield significantly reduces the probability for smearing to occur. The HP Ultrium head and media are designed to minimize the smearing.

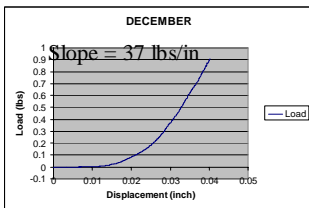
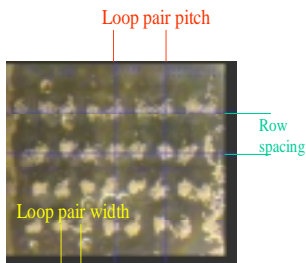
In the HP Ultrium head design, the wrap angle is precisely controlled by head geometry--creating consistent head-tape spacing. The slotted head contour is designed for trapping debris. The slots are specifically designed to get the debris out of the Head Tape Interface (HTI). The debris in the rails is removed via the brushing action of the internal head cleaner. This design was a conscious choice to control debris at the head/tape interface, since slotted heads have been proven successfully for many years in much dirtier customer environments. The head structure is made of an extremely hard and durable ceramic material called Cermet (composite of Al_2O_3/TiC , same material as in disk drive heads).

Long term reliability testing has proven that the HP Ultrium drive, under typical user environment, is capable of running without preventative cleaning and it requires very minimal corrective cleaning.

Brush



New Internal Head Cleaner



Brush pattern and stiffness designed to give effective cleaning.

The Internal Head Cleaner has been designed to last the life of the drive. Life test results estimated useful life of about 20 years.

Preventative Cleaning Using The Internal Head Cleaner

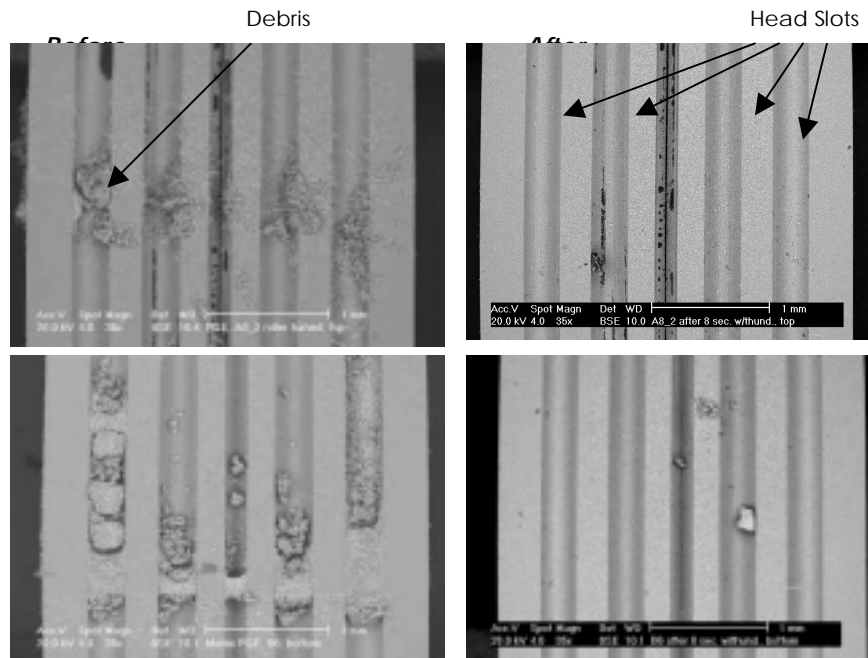
The internal head cleaner is a brush that can be drawn over the heads to 'scrub' away loose debris. It is designed to operate in conjunction with the head contour for trapping and removing media debris. It is non-abrasive to the head and thus can safely be used as frequently as required.

The internal head cleaner is used:

1. Immediately after using a cleaning cartridge.
2. When a cleaning cartridge is being used too frequently*. The drive performs an internal head clean instead of a clean using the loaded cleaning cartridge.
3. As part of error recovery algorithm. For example, if multiple read retries have failed, the tape is unthreaded, the internal head cleaner is operated to remove loose debris, then the tape is re-threaded, and retries begin again.
4. After an unthread, if more than 150 thousand meters of tape have been pulled since the last use of the head cleaner.
5. When the drive detects more than 10% error rate variation between the channels.

How Effective is the Internal Head Cleaner?

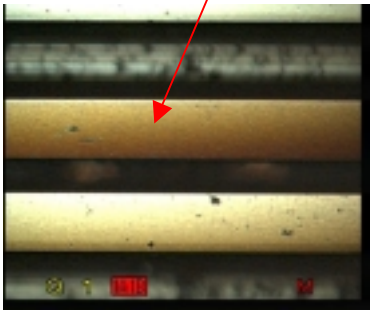
The internal head cleaner is designed with the optimal brush pattern, stiffness and modulus in order to achieve the most effective and efficient cleaning of the slotted head design. HP's extensive testing found that the debris trapped inside the slots is only removable by means of brushing action in the direction of the slot (i.e up and down the head). Without the aid of the head cleaner's brush, the debris would be permanently trapped inside the slots. Even the use of cleaning cartridge is ineffective for cleaning this type of head contamination.



* See Preventing Excessive Cleaning Operation

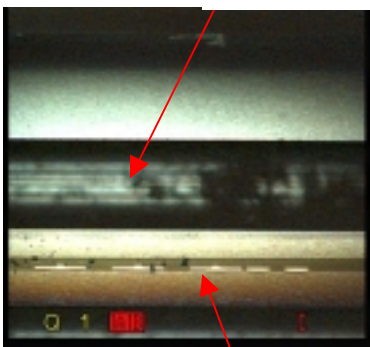
The above pictures demonstrate the effectiveness of the Internal Head Cleaner. Nearly all of the media debris trapped inside the slots on the head was successfully removed after 8 seconds of cleaning using the internal head cleaner. This is one of the reasons that the HP Ultrium drive requires very infrequent use of the cleaning cartridge.

Tape Bearing Surface



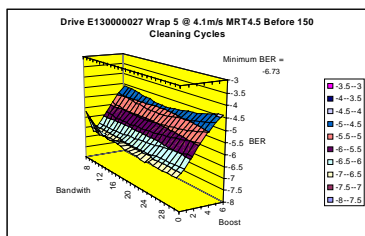
Media debris on Tape Bearing Surface.

Head Slot

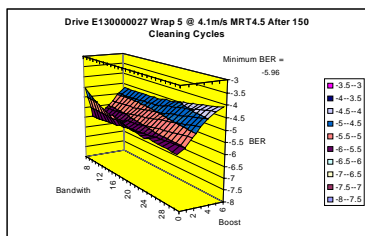


Media debris on the recording element.

Recording Element



Head tuning parameters BEFORE 150 cleaning cycles.



Head tuning parameters AFTER 150 cleaning cycles shows minimal error rate change and stable tuning range.

Corrective Cleaning Using The Cleaning Cartridge

Media debris has demonstrated its propensity to stick to the heads as well as the tape. Depending on the location on the heads, this debris can either be of no consequence to the drive's write/read performance or it can be detrimental when the debris is stuck to the recording elements. Certain usage/environmental conditions promote 'gathering' of media debris on the head/tape interface, which even the best internal head cleaner could not successfully brush away. The cleaning cartridge is designed specifically for removing debris of this type.

Abrasivity plays a critical part in dislodging the sticky debris from the head. When the debris is loose, it can be easily transferred onto the cleaning tape, which is wound into the cleaning cartridge and removed from the drive at the end of the cleaning operation. This is one of the reasons for using a fresh piece of cleaning media for every cleaning operation. Another reason is the abrasivity of the cleaning tape is reduced after each pass over the head, thus producing less effective cleaning.

Different technology results in very different types of media debris formation and cleaning requirement. In DDS technology the cleaning tape is about 200 times more abrasive than normal recording tape. In LTO technology high abrasivity could result in undesired effect such as Pole Tip Recession (PTR). For the HP Ultrium tape drive this high contrast abrasivity is unnecessary. There is less debris being generated, more being trapped by the slotted head contour, and the internal head cleaner frequently brushes loose debris away from the head/tape interface. Also the type of debris generated inside LTO drive appears to be less sticky in nature (compared to DDS). HP has developed a unique cleaning tape that balances PTR with effective debris removal.

What is the Impact of Multiple Cleaning Operation?

The HP cleaning cartridge test data shows only a small degradation results from PTR effect after 390 consecutive cleaning operations. The cleaning cartridge when used in the HP Ultrium drive is good for 15 uses. Assuming user cleans once a week, 390 cleans is equivalent to 7.5 years.

Gauge	Spec	Sample 2-A	Sample 2-B	Sample 2-C
Pole Tip Recession Change	25 nm	22.2 nm	22.4 nm	*16.9 nm
Debris Generation	Minimal	None	None	None
Resolution Change*	N.A.	-0.108	-0.134	-0.103
High Frequency Signal Change*	N.A.	-39.791	-43.540	-26.434
Low Frequency Signal Change*	N.A.	-24.880	-26.152	-14.814
PW50 Change*	N.A.	31.199	36.823	20.658
Beginning Average BER Log ₁₀ (BER) *	- 5.50 <	-7.256	-7.332	-7.201
Ending Average BER Log ₁₀ (BER) *	-3.25 <	-6.815	-6.318	-6.640
Change in Log ₁₀ (BER)	1.6	-0.15 ~ 1.26	-0.05 ~ 2.08	0.09 ~ 1.18

* Parameters are required for proper drive function, and are not in cleaning cartridge qualification based on the First Generation LTO Ultrium Cleaning Cartridge Specification, Revision B.

IMPORTANT: Do not use swabs or other means of cleaning the heads. The cleaning cartridge uses a special tape to clean the tape heads. The user must use only approved Ultrium cleaning cartridges to clean the tape heads. Non-approved cleaning cartridge will be rejected by the drive.

HP Cleaning Algorithm

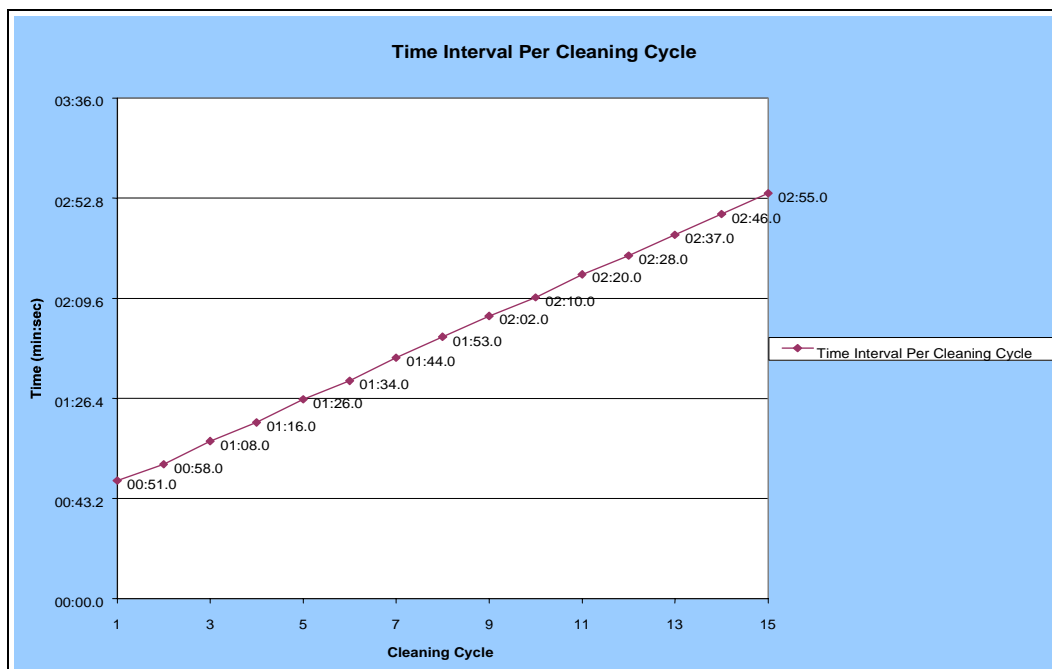
The cleaning algorithm used is critical to the cleaning operation being effective in removing the debris from the head/tape interface. HP has developed a unique algorithm that minimizes PTR and maximizes cleaning effectiveness. The algorithm is as follow:

1. Thread the tape.
2. Start moving the heads up and down.
3. Move to starting point on tape.
4. Run tape over heads at 4 meters per second
5. Run tape over heads at 4 meters per second in the reverse direction.
6. Rewind the tape.
7. Stop moving the heads up and down.
8. Unthread the tape.
9. Operate the internal head cleaner.

Each clean uses 18.4 meters of tape. The first clean is started at 8 meters. Thus the starting point is at distance = $8 + 18.4 * (\text{Thread_Count} - 1)$ meters from BOT.

Duration of a Cleaning Cycle

Every clean cycle uses a fresh piece of cleaning media. This results in the overhead of cleaning time as depicted by the following chart. The first cleaning operation takes 51 seconds, compared to the 15th cleaning operation that takes 2 minutes and 55 seconds because it includes the time it takes the drive to find a new fresh piece of cleaning media.



IMPORTANT: A cleaning cartridge can be used up to 15 times. The cleaning cartridge is ejected immediately if it has expired or if it is not an approved Ultrium cleaning cartridge. Discard it and use a new one.

Role of Cartridge Memory (LTO-CM)

The LTO cleaning cartridge has a cartridge memory device known as LTO-CM. Access to the content of the CM is achieved via the LTO-CM Reader in the drive. The reader communicates to the CM by radio frequency amplitude modulation. The logical layout of the memory device is defined in the U1-ML (rev D) LTO format specification document.



Size of the LTO-CM inside the Cleaning Cartridge.

Many of the page definitions are the same as a normal LTO data cartridge, except there are several pages such as *EOD Information*, *Tape Directory* etc. that are not defined for a LTO cleaning cartridge. Other pages such as *Cartridge Status and Tape Alert* and *Cartridge Manufacturer's Information* are modified to fit cleaning cartridge use. New pages for *Cleaning Usage* are added to track thread count and drive information.

The fields of interest are :

- *Estimated Cleaning Use Remaining*, which indicates the estimated number of times remaining for the cleaning cartridge to be used before it is expired.
- *Thread Count*, which indicates the total number of times that the leader pin has been extracted (threaded) from the cartridge. This value exists in *Cleaning Usage* page as well as *Cartridge Status and Tape Alert* page.

The drive uses these two fields to determine if the cleaning cartridge has expired or not.

Prevention Against Non-Approved Cleaning

The U1-ML format specification provides a method for the drive manufacturers to prevent undesirable cleaning using non-approved cleaning cartridge by end users. Non-approved cleaning media can permanently damage the head and seriously degrade the drive's recording performance. The prevention is achieved through the *Drive Manufacturer Support* page in the LTO-CM. This page contains the unique ID for each drive manufacturer that is supported by the cleaning cartridge. At least one drive manufacturer support page will exist in a LTO cleaning cartridge and the pages are all protected (i.e. it can not be rewritten). The HP Ultrium cleaning cartridge is supported by the HP Ultrium tape drive only.

When a user inserts a cleaning cartridge, the HP Ultrium drive reads the CM and checks the Drive Manufacturer Support page for HP unique ID. If this verification fails then the drive will eject the cleaning cartridge and signal a tape error has been detected. If the verification passes, the drive will proceed to determine if it needs to initialize the CM. For used cleaning cartridge the drive will proceed to determine if the cartridge is expired by checking the *Thread Count* or the *Estimated Cleaning Uses Remaining* field. If it is expired, the drive will eject the cartridge and signal a tape error has been detected. Otherwise, it executes the cleaning algorithm.

The U1-ML format specification prohibits a cleaning cartridge that has been initialized by one LTO drive manufacturer to be accepted and used in a different manufacturer's drive. This is controlled by checking the Initialization Data page for the drive manufacturer ID of the first drive to use/initialize the cleaning cartridge.

The LTO Technology Provider Companies (TPC) have developed the Ultrium Universal Cleaning Cartridge Document which defines the characteristics of a common cleaning cartridge supportable in all LTO Ultrium tape drives to facilitate cleaning cartridge interchange-ability. This new cleaning cartridge is known as the Universal Cleaning Cartridge.



IBM & Seagate Cleaning Cartridge



HP Cleaning Cartridge



For most optimal cleaning performance, use HP brand of Cleaning Cartridge on HP Ultrium tape drive.

Universal Cleaning Cartridge

Universal cleaning cartridge has common physical media characteristics, common LTO-CM page definition, common tape length, common expiry criteria, distinctive marking and unique designator in the CM.

The universal cleaning cartridge (UCC) is truly common amongst the LTO drives. This means a UCC that has been initialized in one manufacturer's drive is recognizable and can be used in all manufacturers' drives. The main advantage of the UCC to an end-user is the full interchangeability of a cleaning cartridge with all LTO drives.

In order to achieve this level of interchange, a specification for the Ultrium Universal Cleaning Cartridge has been developed and approved by the TPC. It specifies that the common cleaning medium is to be the same as the recording media used in data cartridge, and it is not servo written. This cleaning medium is acceptable, tried and tested by all LTO drive manufacturers using their own unique cleaning algorithms.

The specification also defines four changes in the LTO-CM to accommodate the UCC:

- *Universal Drive Support* page, must have "LTO-UCC1"
- *Universal Initialization* field in the initialization data
- *Last Location Used* field in the *Cleaning Cartridge Status and Tape Alert Flags* page.
- *Cleaning Usage* page, also contains *Last Location Used* field

Each LTO drive recognizes a UCC by detecting the *Drive Manufacturers ID* field is set to "LTO-UCC1". The drive proceeds to initialize the cartridge if it is un-initialized. Then it performs the cleaning operation. At the end of the cleaning operation, the drive will update the appropriate fields (such as *Thread Count* and *Last Location Used* etc.) in the CM pages and eject the cartridge. This is all documented in the Ultrium Universal Cleaning Cartridge specification.

Other physical characteristics of the UCC are:

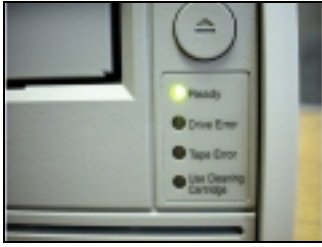
- 319 meters of cleaning media
- Cartridge dimensions are the same as original cleaning cartridge
- No write inhibit tab
- Distinctive mark on the cartridge shell to denote a UCC

Support for the UCC requires new firmware in all LTO drives that recognizes the unique "LTO-UCC1" identifier. The HP UCC firmware will support both the UCC as well as the existing HP cleaning cartridge. HP will utilize the same cleaning algorithm for the UCC and the original cleaning cartridge, which yields 16 cleans per cartridge. The cartridge will be immediately ejected on the 17th cleaning operation when the drive detects that the UCC is expired.

Because each LTO drive manufacturer uses a unique cleaning algorithm the total number of clean per tape will not be the same across all LTO drives. Furthermore, deploying multiple universal cleaning cartridges across multiple LTO drives may yield a different total number of uses per cartridge for each UCC. A consistent number of cleans per cartridge is achievable in a single drive manufacturer usage environment.

The HP universal cleaning cartridge has been subjected to the same rigorous testing as the original HP cleaning cartridge. In addition the TPC technical working group has conducted interchange testing to ensure the UCC is truly interchangeable between all LTO drives. The aim is to launch UCC support across all LTO drive manufacturers at the same time. Soon after the LTO media manufacturers will launch their UCC according to volume availability.

Unique cleaning algorithm results in different total number of uses per cartridge.

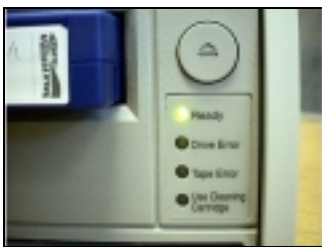


Steady *Ready* LED denotes the drive has successfully powered on. This LED flashes when drive is in operation.



A flashing amber *Use Cleaning Cartridge* LED denotes the drive requests cleaning.

When the cleaning cartridge is inserted, this LED becomes a steady amber.



The amber *Use Cleaning Cartridge* LED is extinguished when cleaning has been successfully completed.

* Certain automation/library usage environment requires the drive not to unload the cartridge unless it specifically requested by the host.

Firmware Behavior

- Inserting a cleaning cartridge into the drive causes the tape drive to automatically load the cartridge, thread the tape and commence cleaning operation.
- During the cleaning cycle the amber '*Use Cleaning Cartridge*' LED is turned on and the green '*Ready*' LED will flash.
- At the end of the cleaning cycle, the drive unthreads the tape and if applicable unloads the cartridge*.
- When the cartridge is ejected, the drive extinguishes the *Use Cleaning Cartridge* LED and if necessary resets *Tape Alert* flag 20.

Note: The drive's *Tape Alert* feature will send a message to your backup application when the tape heads need cleaning or when an expired cleaning cartridge has been detected.

Checking LTO-CM for Approved Cleaning Cartridge

1. As soon as the cartridge is loaded, the firmware reads the CM and uses the Cartridge Type field in the CM to detect that it is a cleaning cartridge.
2. The firmware then checks if the cleaning cartridge is supported by the drive. It uses:
 - *Drive Manufacturer Support* pages to look for HP unique ID, or
 - *Cartridge Manufacturer* field to look for approved media manufacturer's ID. (Note: This method is used to detect cleaning cartridge that has been initialized by older revision of firmware).

Handling Non-Approved Cleaning Cartridge

If the cartridge is determined to be *incompatible* i.e. unsupported in the drive then:

- (i) The cartridge is unloaded (if applicable)*
- (ii) The amber *Tape Error* LED is lit indicating that the Tape is defective. A check condition occurs with a Sense Key of 3 (Medium Error) and an ASC/ASQ of 3007 (Cleaning failure).
- (iii) The Invalid *Tape Alert* Flag (23) is set.
- (iv) If the Cleaning LED and Tape Alert flag 20 were previously set prior to the cleaning cartridge being inserted, then they will remain set.
- (v) Cartridge CM remains unmodified.

Preventing Excessive Cleaning Operation

The firmware performs a check to prevent excessive cleaning being forced upon the drive. Unnecessary cleaning shortens the useful life of a cleaning cartridge as well as risks degrading drive performance.

The excessive cleaning criteria is met if the following is TRUE:

- Cleaning LED is not turned on.
- *Tape Alert* flag 20 is not set.
- Cleaning operation has been performed in the last 336 hours (2 weeks) since the drive was powered on.

If the firmware detects the above condition is true after a cleaning cartridge has been inserted, then

- a) The internal head cleaner is activated to brush the heads.
- b) Estimated Cleaning Usage in the cartridge CM remains the same. I.e. not decremented
- c) Cleaning tape is not threaded.
- d) Cartridge is unloaded (if applicable)* after internal head cleaning has completed its operation.



Subsequent consecutive cleaning does not alter the LED sequence. It activates the Internal Head Cleaner.

Handling Expired Cleaning Cartridge

The firmware uses the thread count and tape length in the CM to check if the cleaning cartridge has been used more than 15 times (i.e. the maximum number of cleaning operations per cartridge).

If it has, then the cleaning cartridge has expired and:

- The cartridge is unloaded (if applicable)*.
- The amber *Tape Error* LED is lit indicating that the Tape is defective. A check condition occurs with a Sense Key of 3 (Medium Error) and an ASC/ASQ of 3007 (Cleaning failure).
- The *Expired Cleaning Media Tape Alert* Flag (22) is set and if the *Use Cleaning Cartridge* LED and *Tape Alert* flag 20 were set prior to the cleaning cartridge being inserted, then they will remain set.
- The cartridge CM is not updated.



The amber *Tape Error* LED is turned on after an expired cleaning cartridge has been detected and ejected by the drive.

Firmware Backwards Compatibility Matrix

There are 3 types of firmware code to consider:

1. Firmware that does not support the *Manufacturers Drive Support* page
2. Firmware that supports the *Manufacturers Drive Support* page
3. Firmware that supports the Universal cleaning cartridge

There are many types of cleaning cartridge to consider:

- a) Universal cleaning cartridge
- b) HP branded and supported cleaning cartridge (initialised by HP drive)
- c) HP branded and supported cleaning cartridge (initialised by the other manufacturer's drive)
- d) HP branded cleaning cartridge (no *Manufacturers Drive Support* page)
- e) Non-HP supported cleaning cartridge
- f) Non-HP branded cleaning cartridge (no *Manufacturers Drive Support* page)
- g) HP supported cleaning cartridge (initialised by HP, not HP branded)
- h) HP supported cleaning cartridge (initialised by other manufacturer's drive, not HP branded)

Tape Type	Firmware Type		
	1	2	3
a	✗	✗	✓
b	✓	✓	✓
c	✓	✗	✗
d	✓	✓	✓
e	✗	✗	✗
f	✗	✗	✗
g	✗	✓	✓
h	✗	✗	✗

Key:

- ✓ - Use
- ✗ - Reject

Note:

- "Use" means the drive loads the cleaning cartridge, executes the cleaning algorithm and ejects the cartridge at the end.
- "Reject" means the drive loads the cartridge and immediately ejects it. The "Tape Error" LED is lit and the Tape Alert flag is set. No cleaning takes place and the drive does not modify the cartridge memory nor initialises it.

Frequently Asked Questions

- **Should I do regular cleaning like DDS?**

The HP Ultrium drive is designed to require very minimal cleaning. The internal head cleaner provides an effective preventative cleaning against head contamination. Regular cleaning using cleaning cartridge is not necessary. Do not use a cleaning cartridge unless the drive requests it and the '*Use Cleaning Cartridge*' LED is lit.

- **Is the internal head cleaner effective in keeping debris away from the heads?**

HP has designed the internal head cleaner with an optimal brush pattern, stiffness and material properties, so that it would produce an effective and efficient cleaning operation. Test data has shown that the brushing action consistently removes media debris from the slots of the head and prevents media debris from building up on the head/media interface.

- **How long will the internal head cleaner last?**

The internal head cleaner has been designed to last the life of the drive. HP has done extensive life testing and the result projects a useful life of 20 years.

- **How can I tell a cleaning cartridge has expired?**

The HP Ultrium drive reads the cartridge memory in a cleaning cartridge and determines if the cartridge has expired or not. Typically a cleaning cartridge is expired when it has been used for about 15 times in a HP Ultrium drive. Subsequent use will cause the drive to eject the cleaning cartridge immediately and lit the *Tape Error* LED. The drive will proceed to clean the heads by activating the internal head cleaner. Library with CM reader can identify an expired cleaning cartridge (without having to load the cartridge) using the MAM attribute 0002h and 0003h commands.

- **Why should HP prevents user from doing excessive cleaning?**

Excessive cleaning operation wastes the useful life of a cleaning cartridge and does not improve the performance of the tape drive. This is to protect user's valuable investment in the HP Ultrium drive.

- **Can I use another vendor's cleaning cartridge ?**

HP recommends the use of HP Ultrium cleaning cartridge in HP Ultrium drive for optimum cleaning result. Other vendor's cleaning cartridge may not have HP unique ID in the LTO-CM and may not produce effective cleaning result. In order to comply with the LTO format specification document, the HP Ultrium drive must reject such cleaning cartridge without altering the content of the cartridge memory. The only exception is the universal cleaning cartridge, which is designed to work in all LTO drives. All LTO cleaning cartridge must be approved and in compliance with the LTO format specification.

- **Why does HP drive reject my cleaning cartridge but another vendor drive accepts it?**

The HP Ultrium drive will reject a cleaning cartridge if the cartridge is not a universal cleaning cartridge and its LTO-CM does not contain HP unique ID or the cleaning cartridge is expired.

Frequently Asked Questions (continue....)

Another vendor's drive may accept the cartridge because the cartridge memory has that vendor's unique ID and/or the drive is not in compliance with the format specification, and/or the vendor's drive detects that the cartridge has not expired yet.

- **Why does HP cleaning cartridge expire after 15 uses when another vendor's cleaning cartridge lasts many times more than 15 uses?**

The HP cleaning algorithm is designed to produce an effective cleaning result against head contamination that is not removable by means of the internal head cleaner whilst maintaining optimal drive performance. This requires the use of a predetermined length of fresh media that only allows 15 uses. Because the HP Ultrium drive is designed for no preventative cleaning using cleaning cartridge, the use of cleaning cartridge is very infrequent and is only reserved for extreme cases. Another vendor's cleaning algorithm may use less media and may produce less effective cleaning result that leads to the drive requiring more frequent cleaning. Less frequent usage of cleaning cartridge is better for the drive and ultimately benefits the user.

- **Will I get the same number of uses from a universal cleaning cartridge across different LTO drives?**

It depends. HP cleaning algorithm ensures the same total number of use if the universal cleaning cartridge is used in HP LTO drive only. Each LTO drive manufacturer uses a unique cleaning algorithm the total number of cleans per tape will not be the same. Using the universal cleaning cartridge in a mixed LTO drive manufacturers user environment (e.g. Library usage) may give a variable total number of use.

- **How does a Universal cleaning cartridge ensure interchange-ability?**

The universal cleaning cartridge will have common physical media characteristics, common update of the LTO-CM pages, a universal drive manufacturer ID, a common designator of usage, a common length, a common expiry criteria and a common mark on the cartridge shell. An initialized Universal cleaning cartridge will be accepted by all LTO drives and maintained in the same way to provide a consistent usage protocol.

- **When will Universal cleaning cartridge be available?**

The LTO Technology Provider Companies (TPC) have agreed on a common introduction date that will allow sufficient time to verify the universal cleaning cartridge performance in all LTO drives.

- **Do I need new firmware in my HP LTO drive for a Universal cleaning cartridge?**

Yes. New firmware is required in all LTO drives in order to support the universal cleaning cartridge. The specification is defined in the Ultrium Universal Cleaning Cartridge Document. The HP UCC firmware will comply with this specification and will also support the existing cleaning cartridge for backward compatibility.