

Dell EMC Tape Systems

LTO Media Handbook

Dell Engineering
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Revisions

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1 Introduction

This document describes media compatibility, handling and usage for all Dell EMC and Dell PowerVault Linear Tape Open (LTO) drives.

2 Drives

Dell EMC LTO tape drives are available in several form factors that can be attached internally and externally to PowerEdge servers or as part of a Dell EMC tape library solution.



Tape Drive	Specifications			
	Capacity (Native / Compression)	Throughput (Native)	Primary Media	Connectivity
LTO8	12 TB / 30 TB	300 MB/s	Ultrium-8	SAS/FC
LTO7	6 TB / 15 TB	300 MB/s	Ultrium-7	SAS/FC
LTO6	2.5 TB / 6.25 TB	160 MB/s	Ultrium-6	SAS/FC
LTO5	1.5 TB / 3 TB	140 MB/s	Ultrium-5	SAS/FC

Table 1 Current LTO drive specifications

Tape Drive	Specifications			
	Capacity (Native / Compression)	Throughput (Native)	Primary Media	Connectivity
LTO4	800 GB / 1600 GB	120 MB/s	Ultrium-4	SCSI/SAS/FC
LTO3	400 GB / 800 GB	80 MB/s	Ultrium-3	SCSI/SAS/FC
LTO2	200 GB / 400 GB	24 MB/s	Ultrium-2	SCSI/FC
LTO1	100 GB / 200 GB	15 MB/s	Ultrium-1	SCSI/FC

Table 2 Historical LTO drive specifications

3 Media

Media comes in both standard Data and WORM (Write Once Read Many) formats for each generation of LTO and is differentiated by color to be easily recognizable. Cleaning cartridges are universal to all LTO generations. Table 3 shows recording information about each media type.

Type	Data Capacity	Recording Format
Ultrium - 8	12 TB (30 TB at 2.5:1 compression)	Reads and writes data on 6656 tracks, 32 tracks at a time.
Ultrium 7 Type M	9 TB (22.5 TB at 2.5:1 compression)*	Reads and writes data on 3584 tracks, 32 tracks at a time.
Ultrium 7	6 TB (15 TB at 2.5:1 compression)	Reads and writes data on 3584 tracks, 32 tracks at a time.
Ultrium 6	2.5 TB (6.25 TB at 2.5:1 compression)	Reads and writes data on 2176 tracks, 16 tracks at a time.
Ultrium 5	1.5 TB (3 TB at 2:1 compression)	Reads and writes data on 1280 tracks, 16 tracks at a time.
Ultrium 4	800 GB (1.6 TB at 2:1 compression)	Reads and writes data on 896 tracks, 16 tracks at a time.
Ultrium 3	400 GB (800 GB at 2:1 compression)	Reads and writes data on 704 tracks, 16 tracks at a time.
Ultrium 2	200 GB (400 GB at 2:1 compression)	Reads and writes data on 512 tracks, 8 tracks at a time.
Ultrium 1	100 GB (200 GB at 2:1 compression)	Reads and writes data on 384 tracks, 8 tracks at a time.

Table 3 Data capacity and recording formats

4 Media colors and markings

Media types are color coded to be easily identified in the data center. Color coding is not an industry standard and varies by distributors. Standard data cartridges are a single solid color. WORM cartridges are differentiated with a grey back cover and the generational color on the front cover. All genuine LTO media will have the Ultrium LTO logo and generation markings on the cartridge.

			
LTO1 - Black	LTO2 - Purple	LTO3 - Slate-Blue	LTO4 - Green
			Dell EMC branded media not currently available. Colors will vary in the market place.
LTO5 - Red	LTO6 - Black	LTO7 - Purple	

Figure 1 Dell EMC historical and current LTO generation cartridge colors

The Ultrium LTO logo is displayed along with the generation number on both the outer cartridge carrier and the physical media cartridge in the lower left corner. Data capacity information is also provided on Dell EMC media.

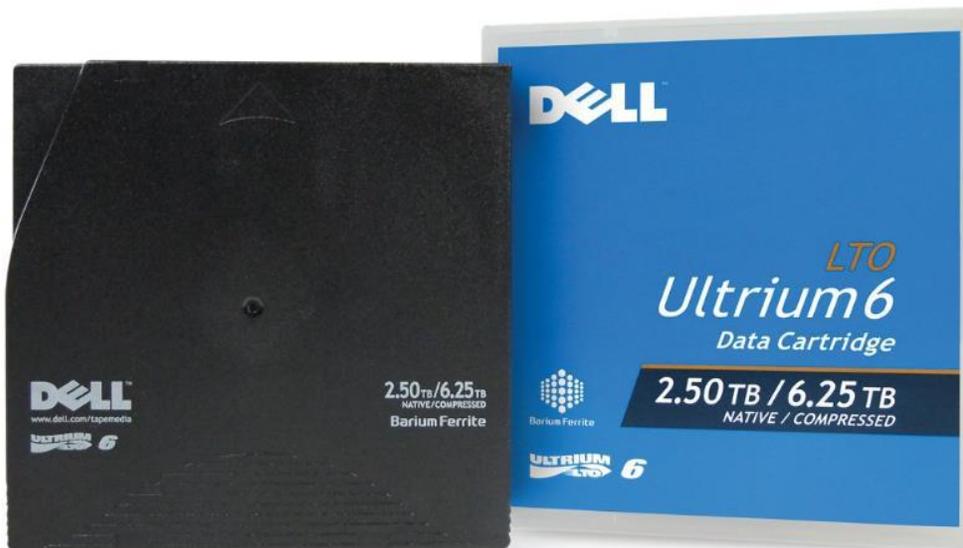


Figure 2 Media markings

WORM cartridges use the same generation color coding for the front or top of the cartridge but have a grey back or bottom cover to visually differentiate.



Figure 3 WORM and standard Data cartridge

5 Media Compatibility

Each new LTO generation aims to achieve the highest bit density possible utilizing the latest technology. Higher bit densities allow more data to be stored on the magnetic medium within the same form factor. These constant improvements to the technology results in a backwards Read/Write compatibility limitation as new generations are brought to the market. Table 4 demonstrates each generation's capabilities.

Tape Drive	LTO Ultrium Data Cartridges								
	12 TB Ultrium 8	9 TB Type M	6 TB Ultrium 7	2.5TB Ultrium 6	1.5 TB Ultrium 5	800 GB Ultrium 4	400 GB Ultrium 3	200 GB Ultrium 2	100 GB Ultrium 1
LTO8	Read/Write	Read/Write	Read/Write						
LTO7			Read/Write	Read/Write	Read Only				
LTO6				Read/Write	Read/Write	Read Only			
LTO5					Read/Write	Read/Write	Read Only		
LTO4						Read/Write	Read/Write	Read Only	
LTO3							Read/Write	Read/Write	Read Only
LTO2								Read/Write	Read/Write
LTO1									Read/Write

Table 4 Tape drive and cartridge compatibility

6 Cleaning cartridges

Universal Cleaning Cartridges (UCC) are designed to be used with all LTO generations. The color of the Dell EMC UCC is Black. Certified cleaning media will contain the LTO Ultrium logo in the lower left corner and will have a Universal Cleaning Cartridge designation printed on the front. Other artwork may vary.

Cleaning cartridges that were manufactured prior to the release of a newer generation LTO drive may not contain the correct drive generation information printed on the front of the cartridge, this does not limit that media from being universally accepted in the newer generation LTO drives. All LTO generations to date use the same UCC cartridge.

Each UCC is capable of performing 50 cleaning routines.

6.1 Usage

LTO drives have built in algorithms to determine when the tape heads need to be cleaned. It is always best to allow the drive to determine when a cleaning is required. Excessive cleaning of the tape heads will degrade head performance. The drive will alert the user when a cleaning is required. There are two main criteria used by the drive to call for cleaning:

- **Clean required (also known as Clean Now TapeAlert 14h)**

Clean required is triggered when the drive posts specific permanent errors or is running degraded. It is not based on temporary or permanent error rates. The permanent errors are typically read/write perms or servo related perm failures. Not all read/write or servo perms will trigger a clean. The errors are typically sticky, which means that the drive may not allow data operations unless a clean is performed, even if a power cycle occurs.

- **Clean Requested (also known as Clean Periodic TapeAlert 15)**

Clean Requested is based on usage, but not media motion hours. Two criteria are used, Data sets processed or Meters of tape pulled across the head.

LTO drives will post a “C” on the Single Character Display (SCD) and send the tape alert information to the host application and library, if the drive is part of an automated solution. If another cartridge is inserted after a clean is requested, the drive continues to operate however the ‘C’ on the SCD of the drive persists until the drive is cleaned or power cycled. If the drive is power cycled, the ‘C’ will reappear on the SCD until the drive is cleaned. Libraries can be setup to automatically perform the clean operation without user interaction; check library Users Guide for more detailed information.

Once the UCC is inserted, the drive will determine if cartridge has cleaning cycles remaining. If the tape is valid the cleaning routine will start automatically. During the cleaning routine the drive activity light will blink green and the SCD will display “C”. When complete the drive will increment the clean count by one for that cartridge and eject. The drive will post a tape alert to the host application and library interface indicating a successful clean.

If an expired UCC is inserted into an LTO drive the drive will alert the user by posting a “7” and flash the activity light amber. A tape alert message is generated. The clean routine will not be run and a new UCC will be required.

7 WORM cartridges

WORM stands for Write Once, Read Many. This means once data is written to a piece of WORM media, the data on the tape cannot be changed or overwritten. WORM media can be appended to if data is already present on the tape. The media also stores unique identifiers which allow the drive to determine whether or not the media has been tampered with.

WORM media offers a method of data retention for compliance laws such as the Sarbanes-Oxley Act of 2002.



Figure 4 WORM media

8 Write Protection

To preserve data on the cartridge from being overwritten or erased use the Write Protect tab. The tab must be engaged prior to inserting the media into the drive. Do not slide the tab while media is already inserted in a drive.

When properly write protected a lock symbol will be visible on the red tab of the cartridge and the SCD on the drive will display the character “P” when cartridge is inserted. If the drive does not display the character “P” eject the cartridge and inspect the slide tab to insure it is properly closed (locked) and reinsert.

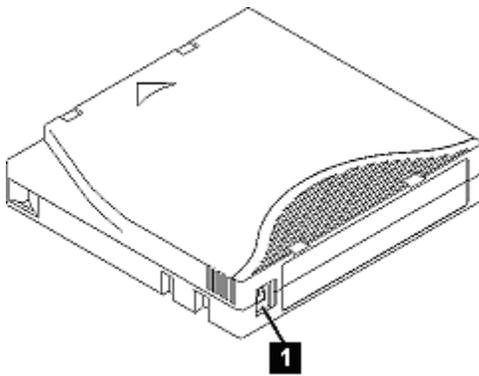


Figure 5 Write Protect Tab

9 Cartridge Memory

Tape drives require information about the tape cartridge being used. For LTO tape cartridges, this information is stored in a small chip within the tape and is referred to as the Cartridge Memory (CM). CM is a nonvolatile memory that responds through a passive radio frequency interface.

The CM holds the following information:

- The type of cartridge
- Important information that the drive uses to setup and calibrate
- The tape directory to enable a quick search for data sets

You experience difficulties with the cartridge if the CM is damaged or corrupted. However, the user data can still be recovered. To recover the data, set the write protect tab on the cartridge and load the cartridge into an Ultrium drive.

The drive stores enough information on tape to be able to recognize the tape. However, the data directory is lost. Hence, the drive can only search from the beginning of tape (BOT) to end of tape (EOT) across all wraps to find the data. A Fast Search to the correct location is not possible.

10 Barcodes

A bar code label contains:

- A volume serial number (VOLSER) that is human-readable
- A bar code that the library can read

When read by a library's bar code reader, the bar code identifies the cartridge's VOLSER to the library. The bar code also tells the library whether the cartridge is a data cartridge or cleaning cartridge. In addition, the bar code includes the two-character media-type identifier Lx, where x equals 1-8. L identifies the cartridge as an LTO cartridge and the number represents the generation of cartridge for that cartridge type.

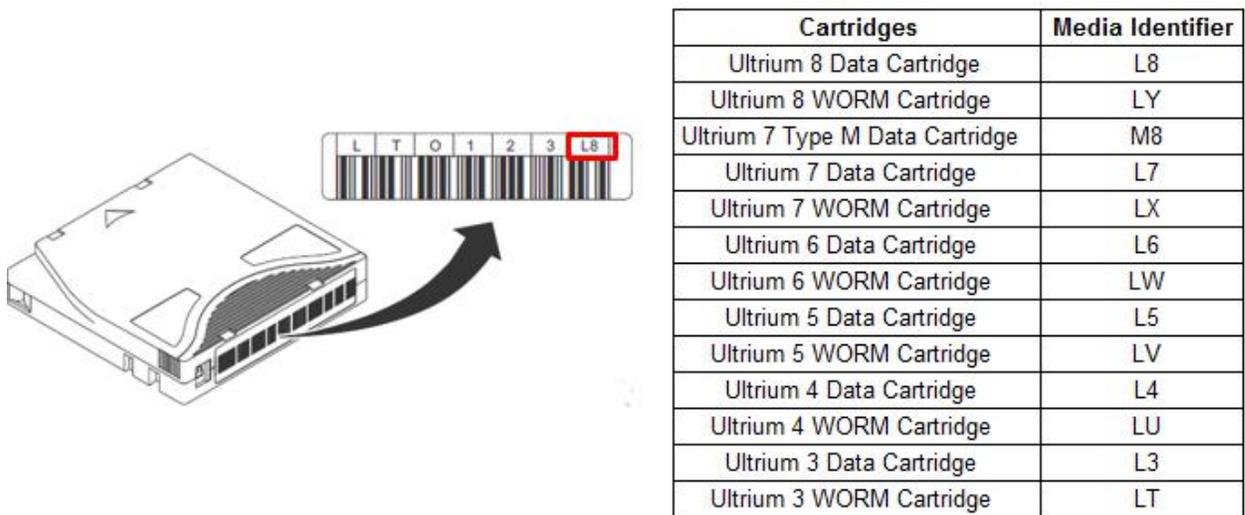


Figure 6 Barcode label and Media Identifier.

Dell EMC cleaning media barcodes will have a VOLSER of CLN for the first three characters and the media identifier will be either L1 or CU.

11 Media Handling

11.1 Media Description

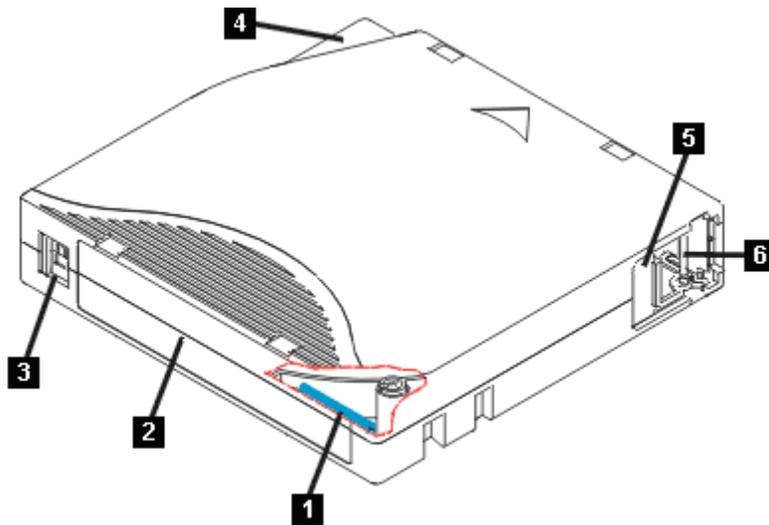


Figure 7 LTO Ultrium Data Cartridge

1. LTO CM
2. label area
3. write-protect switch
4. insertion guide
5. cartridge door
6. leader pin

11.2 Inspection

Inspect the cartridge packaging to check for any rough handling.

- When inspecting a cartridge, open only the cartridge door. Do not open any other part of the cartridge case. The upper and lower parts of the case are held together with screws; separating them destroys the usefulness of the cartridge. While the door is open, check that the leader pin is properly seated. If the cartridge has been dropped, it is likely that the pin is dislodged inside the cartridge. It is recommended that you open the door and check if the pin is properly seated before each use.

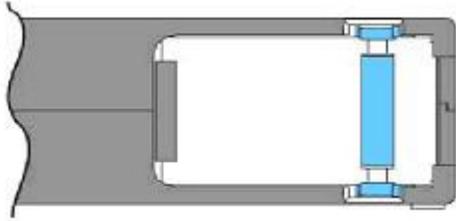


Figure 8 Correct Leader pin location

- Inspect the cartridge for damage before using or storing it.
- Inspect the back of the cartridge (the part that you load first into the tape load compartment) and ensure that there are no gaps in the seam of the cartridge case. If there are gaps in the seam, the leader pin may be dislodged. See Figure 6.
- If you suspect that the cartridge has been mishandled but it appears usable, copy any data onto a good cartridge immediately for possible data recovery. Discard the mishandled cartridge.

11.3 Handle the Cartridge Carefully

Do not drop the cartridge. If the cartridge drops, slide the cartridge door back and ensure that the leader pin is properly seated in the pin-retaining spring clips. See Figure 6.

- Do not handle tape that is outside the cartridge. Handling the tape can damage the tape surface or edges, which may interfere with the read or write reliability. Pulling on tape that is outside the cartridge can damage the tape and the brake mechanism in the cartridge.
- Do not stack more than six cartridges.
- Do not degauss a cartridge that you intend to reuse. Degaussing renders the tape unusable.

Figure 7 displays a dropped tape which resulted in a dislodged leader pin. This cartridge if inserted into a drive could result in a stuck tape. Other damage could result in the leader pin falling out of the cartridge or getting dropped inside the tape housing.



Figure 9 Dropped leader pin

Figure 8 shows an LTO cartridge that was dropped and caused damage to the casing.



Figure 10 Split seam on case.

11.4 Ensure Proper Packaging While Shipping

- When you ship a cartridge, ship it in its original or better packaging.
- Always ship or store a cartridge in the vertical orientation and inside the jewel case to prevent damage to the tape edge.
- Use only a recommended shipping container that securely holds the cartridge in its jewel case during transportation.
- Never ship a cartridge in a commercial shipping envelope. Always place it in a box or package.
- If you ship the cartridge in a cardboard box or a box of a sturdy material, ensure the following:
- Place the cartridge in polyethylene plastic wrap or bags to protect it from dust, moisture, and other contaminants.
- Pack the cartridge snugly. Do not allow it to move around.
- Double-box the cartridge (place it inside a box, then place that box inside the shipping box) and add padding between the two boxes.

11.5 Cartridge Storage Conditions

- Before you use a cartridge, let it acclimate to the normal operating environment for 24 hours.
- Ensure that all surfaces of the cartridge are dry before use.
- Do not expose the cartridge to moisture or direct sunlight.
- Always ship or store a cartridge in the vertical orientation and inside a jewel case to prevent damage to the tape edge.
- Do not expose recorded or blank cartridges to stray magnetic fields (for example, terminals, motors, video equipment, X-ray equipment, or fields that exist near high-current cables or power supplies). Such exposure can lead to loss of data or render the blank cartridge unusable.
- Maintain the environmental conditions outlined in the Table 5.

Environmental Factor	Operating	Operational Storage	Archival Storage	Shipping
Temperature	10 °C to 45 °C (50 °F to 113 °F)	16 °C to 32 °C (61 °F to 90 °F)	16 °C to (61 °F to 77 °F) 25 °C	-23 °C to 49 °C (-9 °F to 120 °F)
Relative humidity (non-condensing)	10 % to 80 %	20 % to 80 %	20 % to 50 %	5 % to 80 %
Wet bulb temperature	26 °C (79 °F)	26 °C (79 °F)	26 °C (79 °F)	26 °C (79 °F)

Table 5 Storage conditions

11.6 Cartridge Life

- Durability – 1,000,000 passes on any area of tape, equates to over 20,000 end-to-end passes/260 full tape backups.
- Archival life – 30 years.

12 LTO7 Type M media

The LTO consortium approved a new media format to be used with LTO8 tape drive technologies. The new LTO7 Type M media format will allow an LTO8 drive within a supported Dell EMC library to format a new, unused, LTO7 tape cartridge for 9TB of native data capacity. The media designator for the LTO7 Type M format is M8.

12.1 Using LTO7 Type M media in Dell EMC tape libraries

To utilize the LTO7 Type M format the LTO8 drive, library and tape cartridge must all meet minimum requirements:

- Tape Drive must be at Firmware Revision HB8x or higher.
- Library Firmware must be at Firmware Revision:
 - ML3 – 1.1.1.1-B00 or higher
 - TL1000 – 0080.3000 or higher
 - TL2000/TL4000 – Future release
 - ML6000 – Future release
- LTO7 tape cartridge:
 - Uninitialized and unformatted to LTO7 Type M:
 - Must have an M8 designated barcode.
 - Must be new non formatted cartridge.
 - Initialized and formatted to LTO7 Type M:
 - Must have an M8 designated barcode.

12.2 Using LTO7 Type M media in Dell EMC tape drives

Standalone LTO8 tape drives will write or read to the 9TB format provided the drive is at firmware version of HB8x or higher and the tape has ALREADY been formatted with the LTO7 Type M format. Standalone tape drives do not have a process to format uninitialized LTO7 media into the Type M format.

12.3 Formatting an LTO7 Type M tape in a Dell EMC library

To create Type M media from LTO7 cartridges in a Dell EMC tape library users must only insure all hardware and cartridges meet the requirements from section 12.1. The remaining steps will be transparent to the end user.

When a backup job begins the backup application will signal to the library to move a piece of media from a slot to a drive. The library will scan the barcode, pick the media and signal to the drive the media type prior to inserting it into the drive. The tape cartridge is initialized when it is first loaded into the drive and data is written by the backup application at the beginning of tape (sometimes referred to as "labeling a tape" or "writing from BOT"). The tape drive then establishes the density of the media.

There must be a Write from BOT before the media will format to the 9TB capacity. Simply loading a tape into the drive and ejecting it will not format the media.

13 Troubleshooting & Best Practices

This section contains helpful information to maintain the highest level of service from you LTO drive.

13.1 Stuck tape

A stuck tape can result from a dropped or damaged media. Different drives react differently when damaged media is inserted. Some may eject the tape, while others may be stuck permanently with the drive and require the drive to be returned. Most LTO drives have the capability to reset the drive in the event of a stuck tape or other non-responsive drive issues.

13.1.1 Drive reset

Use this procedure to reset your LTO tape drive:

1. Press and hold the Eject button for more than 10 seconds.
2. Release the Eject button.
3. Press eject again to eject tape.

Once drive resets the SCD will begin a count down from 9 to 0 while the media is slowly being rewind. The drive countdown may be slow depending on where the media was positioned prior to reset. Wait until media is ejected by the device.

13.2 Media Do's and Don'ts

13.2.1 Do's

- Store cartridges in their protective cases.
- Handle cartridges with great care.
- Store the cartridge vertically.
- Align cartridges so the grooves interlock.
- Inspect cartridges prior to each use.
- Unload cartridges prior to turning off the drive.
- Allow a 24-hour conditioning period to the operating temperature and humidity before using new or stored cartridges.

13.2.2 Don'ts

- Touch the media or leader with bare fingers.
- Use pens or pencils during cartridge inspection.
- Drop cartridge.
- Store the cartridge horizontally.
- Disassemble cartridges.
- Store near magnetic fields (e.g. speakers, monitors, electric motors, power supplies, etc.).
- Use a cartridge that fell from 3 ft or higher.
- Degauss LTO tapes.

- Ship the LTO drive with media loaded.