# HP StorageWorks Tape Bar Code Label Requirements, Compatibility, and Usage

# Abstract

The bar code labels on tape cartridges provide both human-readable and machine-readable identifiers. Machine readable identifiers enable the tape library system to correctly manage the tape cartridges. Any failure in the card code label system with the label and format, the library reader, or the application, can cause data to be inaccessible. Backup and restore failures are often caused by misuse or misunderstanding of bar code technology.

This paper discusses the many factors required to use bar code labels successfully in the tape backup environment.

# Technical requirements of bar code labels

## History of bar codes

Bar code label technology patents go back to 1934. While the idea of encoding information in a series of bars and spaces is not new, the application in the world of tape automation has added new and significant value to users of tape technology, enabling them to track their media both within automation products and at offsite locations. Many third parties use additional labeling for offsite tape storage, typically on the tape storage case. Application software is also evolving to use the bar code information to track where the data cartridge is located, verify the correct media type, and confirm the identity of the exact piece of media being accessed.

Bar code technology, like other languages, has evolved into many symbologies suited for different applications. Over 200 different bar code symbologies have been developed. The most familiar symbology is the Universal Product Code (UPC) used on consumer merchandise such as food products. UPC labels are simple, strictly formatted, and designed to allow low quality labels to be read by highly sophisticated readers. UPC codes on merchandise have the benefit of being used in an environment where the reader can be moved to many locations on the label, often by a hand-held reader or multiple beam scanner, scanning the label possibly hundreds of times to determine a good scan. Checksums are included in the coding scheme to verify the scan. As a last resort, the UPC label usually has a human-readable portion that can be typed into the terminal by an operator.

## Bar code technology in tape libraries

Bar code labels for tape media use the Code 39 (sometimes referred to as Code 3-of-9) symbology— a widely used industrial standard. As the name implies there are three wide elements (and six narrow elements) for every nine elements. An element can either be a bar (black, non-reflective) or a space (white, reflective). This format provides verification that a valid code is present. For example, a character with four wide elements and five narrow elements would be considered invalid because it must contain exactly three of nine wide elements. The Code 39 specification allows for the addition of a checksum digit. However, for most tape media a checksum digit is not used (with the exception of the bar code label for AIT products). Code 39 uses an asterisk as the stop and start characters. These are not printed as part of the human-readable portion of the label. A bar code reader can determine the start character and the stop character, and can therefore determine the intended direction of the characters regardless of which direction they are read. The reader is able to do this by analyzing the direction of the start or stop character relative to the lead-in white space on the label. This prevents the label from being read backwards.

With tape libraries and tape autoloaders, the ability of the reader to reposition itself with respect to the label is much more restricted than the hand held or multiple beam scanners used for reading UPC codes. Often, the reader is at a fixed distance and angle from the bar code label. The only variable available to the reader is to scan in different positions across the label. While these restrictions allow for a more cost-effective reader to be used compared to scanners in a retail environment, they put a greater emphasis on the quality of the label. Because of the physical constraints of the reader and the inability to have an operator standing by to manually enter the human readable portion of the label,

the quality of the label must be much higher than that of the common UPC label. Failure to properly read a label carries greater consequences given the importance of the cartridge data in today's computing environment. The importance of using a high quality label cannot be overstated.

## Label quality

Many factors contribute to the quality of a label. Some factors are obvious and observable to the human eye, but most factors require specialized optical measurement equipment to qualify them. The following are some of the factors that determine label quality:

- *Lead-in white space* before the first character and after the last character should have a minimum width of 10 narrow elements. This allows the reader to verify when to start looking for the first character and when to validate the last character. Without this, the reader may have difficulty determining the start of the bar code label. Avoid labels that use insufficient white space for these guard zones.
- *The white space should be very reflective*, but also contain a spatial distribution attribute. A very reflective, shiny surface (like a mirror) may actually appear black to the reader because the angle of reflection does not return sufficient light to the receiver of the reader. A white surface that reflects the light in many directions (spatial distribution) enables the bar code reader to detect white areas accurately.
- *The black space should not be reflective*. Again, the factor of spatial distribution of the reflected light comes into play. Even though the area may appear black to the human eye, if the surface is highly reflective along an angle aligned back to the receiver, the black area will actually be read as white to the reader.
- *The ratio of narrow to wide elements* is crucial to the ability of the reader to distinguish wide elements from narrow elements. If the narrow and wide elements begin to appear too similar to the reader, incorrect reads will result. The edge definition between the black and white elements can appear different to the reader than to the human eye, if that transition is not crisp. Edge definition and edge location are common faults when personal printers are used to create bar code labels.
- *The size of narrow elements* must not be too small. If the element is too narrow it does not carry enough information for the reader to accurately process it, or it may not be detected at all. The element width, ratio specification, label size, and the lead-in white space all combine to create a physical limit on the number of characters that a label can contain. Exceeding this number may cause read problems.
- *The quality rating* of the label should be high. The standard ANSI X3.182 Bar Code Print Quality Guideline, which takes all factors into account, is used by all verifier manufacturers to rate bar code labels. All Hewlett-Packard libraries require the highest quality rating of "A." This standard rating includes measurements of voids or white areas within the black bars and specks or dark areas within the white bars. Either of those can be very detrimental to successfully reading a label.
- *Miscellaneous other factors* affect the quality of the label such as if the ink on the label is waterproof, how well the adhesive properties of the label are maintained over time, and if the label material can resist the wear from both human and machine handling. These factors are important to protecting the integrity of the data cartridge.

## Label manufacturing processes

There are two processes commonly used for manufacturing quality tape media bar code labels. One uses a thermal transfer process and the other uses industrial quality laser printers with a laminate overlay.

- *Thermal transfer printers* produce a label with very good white to black transitions. If controlled well, this process has an acceptable level of voids in the black regions and specks in the white regions. The label from this process has a more shiny appearance—both to the human eye and to

the bar code reader. Consequently, some readers such as CCD readers may experience difficulty distinguishing black from white. Generally, laser readers tend to work somewhat better with thermal transfer labels.

- *Industrial quality laser printers* can print very good quality labels. The transition from white to black is not quite as sharp as the thermal transfer process but can still have the quality to achieve grade "A" classification. The laminate overlay protects the label from environmental factors such as water and abrasion. It also helps to scatter the light, which is beneficial to some readers, particularly CCD scanners. However, this same scattering may be detrimental to some laser scanners.

Labels printed on other types of printers such as ink jet printers or office quality laser printers generally lack the high quality required to provide reliable reads in a tape library. Additionally, these types of labels may work in one library at one time but may not read on that library in the future. A label that reads in one library may not be interchangeable with other libraries of the same model, or with different models of libraries. The ink and stock material are also subject to water damage, smearing, wear, abrasion, and possible fading over time. This can be a problem when attempting to recover data from a cartridge that has been in storage. Similarly, labels made with adhesive strip label makers or low quality thermal transfer printers will cause problems with interchange and reliable reading.

## Label types

Tape labels are of two types: non-adhesive, and adhesive. The non-adhesive labels are used in the DLT family of tape cartridges. The adhesive labels are used in LTO, AIT, 3480, 9840, and other tape formats.

- *Non-adhesive labels*—The slide-in label for the DLT & SDLT formats has the advantage of being oriented to the cartridge by the nature of the slot. Labels can be placed in the slot in either orientation, although the convention is to place the human readable part of the label away from the hub side of the tape. This would be consistent with how one would want the label on the cartridge to appear if using a stand-alone drive and inserting the tape with the hub down. The slot length for DLT cartridges is not as long as other tape cartridge types, so it is strongly suggested that no more than seven characters be present on the label (not counting the start and stop characters).

**Figure 1**: Inserting a non-adhesive label

- *Adhesive labels*—The LTO cartridge (as well as AIT, 9840, 3480, and others) uses a label with an adhesive backing that is applied by the user. Great care must be taken to ensure that the label is applied within the recess of the cartridge. Labels applied outside of the recess can cause label reading inconsistencies.

  Hewlett-Packard LTO labels must be oriented correctly on the tape. The label has a note indicating which side should be applied towards the hub of the tape. Failure to apply the label correctly may make the label unreadable or not interchangeable with all HP tape libraries. The HP LTO1 and LTO2 label formats contain a short bar code and a long bar code (known as the dual bar code label) as shown below. This dual bar code label was used in some older HP tape libraries. LTO label formats (with a single bar code) work with all newer HP tape libraries.

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**Figure 2**: LTO label formats
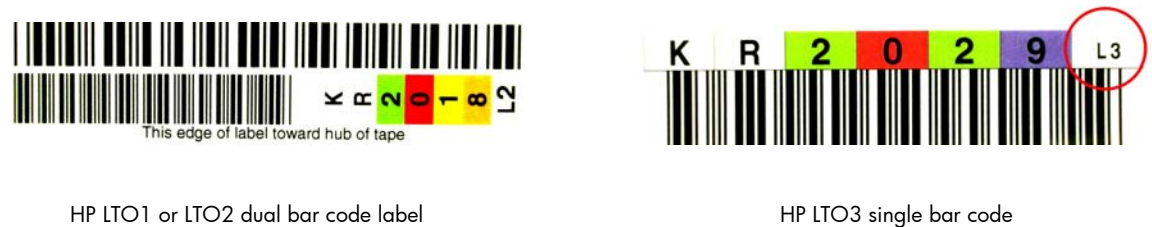


HP LTO1 or LTO2 dual bar code label                    HP LTO3 single bar code

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**CAUTION:**
Never apply a label from a different media type, such as 3490, to LTO cartridges. The bar code could be unreadable, and the label might get jammed in the drive or library robotics. Additionally, the label might be readable, but the library could misinterpret the type of cartridge and proceed to insert the cartridge into an incompatible drive, possibly damaging the drive and/or tape.

## Technical aspects of bar code readers

There are two types of bar code readers: One type uses scanning lasers, and the other type uses Charge Coupled Device (CCD) technology. Each type has benefits and drawbacks. Both are used in tape automation products.

- *Scanning laser readers*—The scanning laser is a concentrated beam of light that is mechanically scanned across the surface of the bar code, usually by sweeping a mirror internal to the bar code reader device. As the beam passes over the bar code, a receiver analyzes the returning light to determine how much of the laser light is being reflected back into the receiver. A threshold is determined that separates the white areas of the label from the black areas. Because the speed with which the beam is being scanned across the label is known, the apparent width of the narrow and wide elements can be determined. This information is then processed to determine the information on the label. Precaution must be taken with laser scanners so that the laser is not directed into the eyes of the user or service technicians.
- *CCD readers*—The CCD scanner consists of a light source, usually an array of LEDs, that illuminates the entire label. A CCD then reads the entire image of the field of view at once. The CCD is a single line scan with each pixel representing one part of that line across the entire bar code. The amount of light received by each pixel is correlated to either a black area or a white area. The number of pixels each element contains is used to distinguish wide from narrow elements. A label

surface that uniformly scatters the light from the LEDs in many directions (like a high quality HP label) is the best for these types of scanners.

Higher quality readers are able to read labels more precisely, but this greater precision and sensitivity can cause more read issues with poor quality labels. The same precise reading capability that allows a greater margin for reading quality labels also emphasizes voids and specks in low quality labels. These voids and specks can result in read errors. However, regarding other label quality criteria such as the narrow-to-wide ratio and reflectivity, a high quality scanner provides a greater margin of error to allow for lower ratios and worse reflectivity than a low quality reader. A high quality label is the best way to ensure total compatibility across all reader types and quality.

# Format conventions for bar code labels

In addition to the technical details of how the information is encoded on the label and read by the scanner, the information for tape media bar code labels is governed by format conventions. For this paper, the formats for both DLT and LTO types of tape will be reviewed, including the formats for data, cleaning, and diagnostic cartridges of each technology. Some of the format criteria are conventions used to standardize (as much as possible) between automation and tape manufacturers. Other format criteria are required by some tape automation products, some application software products, or both. Those elements will be discussed in more detail in sections of this paper devoted explicitly to automation and software requirements.

## LTO type formats

The LTO (Linear Tape Open) Ultrium tape format now includes Generation 1 drives and media (200 GB), Generation 2 drives and media (400 GB) and Generation 3 drives and media (800 GB). With the exception of the cartridge color (HP branded Gen 1 = blue, HP branded Gen 2 = red, HP branded Gen 3 = yellow-gold, and yellow-gold/gray for WORM media), the cartridges appear very similar. The only difference is the format of the information on the label.

The following table provides additional data about LTO media and drive interoperability.

**Note:**
All capacities are 2:1 compressed capacities.

|                    | LTO1 Media | LTO2 Media | LTO3 Media | LTO3 WORM Media |
| ------------------ | ---------- | ---------- | ---------- | --------------- |
| **LTO1 Drive**     | 200 GB     | N/A        | N/A        | N/A             |
| **LTO2 Drive**     | 200 GB     | 400 GB     | N/A        | N/A             |
| **LTO3 Drive**     | 200 GB     | 400 GB     | 800 GB     | 800 GB          |
| **Tape length (feet)** | 1998   | 1998       | 2230       | 2230            |
| **Cartridge Color** | Blue      | Red        | Yellow-Gold | Yellow-Gold/Gray |

The following is the compatibility matrix for these HP media types:

| HP Ultrium data cartridges & magazines | Product Number | Ultrium 215 half-height drive | Ultrium 232 half-height drive | Ultrium 448 half-height drive | Ultrium 230 full-height drive | Ultrium 460 full-height drive | Ultrium 960 full-height drive |
|---|---|---|---|---|---|---|---|
| HP Ultrium 200 GB data cartridge, blue | C7971A | R/W | R/W | R/W | R/W | R/W | R only |
| HP Ultrium 200 GB prelabeled data cartridge, blue | C7971AL | R/W | R/W | R/W | R/W | R/W | R only |
| HP Ultrium 400 GB data cartridge, red | C7972A | N/C | N/C | R/W | N/C | R/W | R/W |
| HP Ultrium 400 GB prelabeled data cartridge, red | C7972AL | N/C | N/C | R/W | N/C | R/W | R/W |
| HP Ultrium 800 GB RW Data Cartridge, yellow-gold | C7973A | N/C | N/C | N/C | N/C | N/C | R/W |
| HP Ultrium 800 GB RW prelabeled data cartridge, yellow-gold | C7973AL | N/C | N/C | N/C | N/C | N/C | R/W |
| HP Ultrium 800 GB *WORM Data Cartridge, yellow-gold/gray | C7973W | N/C | N/C | N/C | N/C | N/C | R/W |
| HP Ultrium universal cleaning cartridge, orange | C7978A | C | C | C | C | C | C |

*N/C = Not Compatible, C = Cleaning, R/W = Read and Write compatible*

*\*2:1 Compressed Data Capacities*

The full specification of the label format is as follows:

1. The label will always contain exactly eight (8) characters. These will consist of six (6) volume identifier characters followed by two (2) media identifier characters. The volume identifier characters will be limited to the use of ASCII characters A-Z (41h-5Ah), 0-9 (30h-39h) in any order with the exception that the special combinations of "CLN" and "DG(space)" as described in Note 3 should not be used as normal volume identifiers.
2. The two (2) media ID characters must be included and must follow the volume identifier. The media characters must consist of two ASCII characters limited to A-Z (41h-5Ah) and 0-9 (30h-39h) defining the type of cartridge being used. Currently, the character string *Lg* is used, where *L* designates the LTO type of cartridge. The next character *g* (alphanumeric) designates a generation of the LTO cartridge. Other designations for this field will be created with future media types.
3. This note applies to cleaning and diagnostic cartridges only. The first three alphanumeric characters in the sequence will determine a special type of cartridge. Diagnostic cartridges will be [*DG{space}vnn*], where *DG{space}* is the Diagnostic cartridge identifier, *v* is the drive type identifier, and *nn* is a sequence of numbers (example: DG 100). Currently, HP does not support the use of LTO diagnostic cartridges.

The cleaning cartridges will be [*CLNvnn*], where *CLN* is the Cleaning cartridge identifier, *v* is the drive type identifier, and *nn* is a sequence of numbers (example: *CLNH99L1*). The cleaning cartridge identifier for LTO is *L1* for the Ultrium universal cleaning cartridge used in LTO1, LTO2 and LTO3 drives.

Only ASCII characters A-Z (41h-5Ah) and 0-9 (30h-39h) may be used. These strings must always be exactly six characters.

The following sections give a more detailed description of the known possible and allowed media identifiers for LTO cartridges.

**LTO data cartridge format: *nnnnnnXY***

Where:

- *nnnnnn* is the volume serial number (when color coded, it is called *volser*). The volume serial number must be exactly six alphanumeric (A-Z, 0-9) characters.
- *XY* is the media ID. These must be alphanumeric. The following table lists the valid media ID combinations:

| X | Y | Description |
|---|---|---|
| L | 1 | LTO 1st Generation Data Tape 100% length (200 GB Compressed) |
| L | 2 | LTO 2nd Generation Data Tape 100% length (400 GB Compressed) |
| L | 3 | LTO 3rd Generation Data Tape 100% length (800 GB Compressed) |
| L | 4 | LTO 4th Generation Data Tape 100% length (1600 GB Compressed) |
| L | 5 | LTO 5th Generation Data Tape 100% length |
| L | 6 | LTO 6th Generation Data Tape 100% length |
| L | 7 | LTO 7th Generation Data Tape 100% length |
| L | 8 | LTO 8th Generation Data Tape 100% length |
| L | 9 | LTO 9th Generation Data Tape 100% length |
| L | R | LTO 1st Generation WORM media |
| L | S | LTO 2nd Generation WORM media |
| L | T | LTO 3th Generation WORM Data Tape 100% length (800 GB Compressed) |
| L | U | LTO 4th Generation WORM Data Tape 100% length (1600 GB Compressed) |
| L | V | LTO 5th Generation WORM media |
| L | W | LTO 6th Generation WORM media |
| L | X | LTO 7th Generation WORM media |
| L | Y | LTO 8th Generation WORM media |
| L | Z | LTO 9th Generation WORM media |

**LTO cleaning cartridge: *CLNvnnXY***

Where:

- *CLN* denotes that this is a cleaning cartridge
- *v* is the drive type (drive manufacturer or universal) (Alpha only A-Z)
- *nn* is the volume serial number (numeric only 0-9)
- *XY* is the media ID (or *volid* = volume ID)

The universal cleaning cartridge is currently used and preferred by all manufacturers. The cleaning cartridge is defined in two places in the bar code label. This is because some automation vendors use the CLNvnn portion and others look at the media identifiers (XY) to determine the media type. This duplicate information allows the cartridge to be universally recognized by all hardware.

## DLT type formats

DLT tape and drive types are divided into three versions: DLT, DLT1, and SDLT. The first of these versions to be developed was DLT. The media was known as Type III media and was used with the first DLT-2000 drives. With the advent of the DLT-4000 drive, the Type IV media (also referred to as Compact 4 media) was developed. Type IV media is still used in the DLT-8000 drive.

The DLT1 and VS80 drives, developed by Benchmark (now part of Quantum), use Type IV media, but the format is not fully compatible with the other DLT drive types. Also, the DLT1 and VS80 drives require a cleaning cartridge that is unique to them. Quantum also developed DLTape VS1 media specifically for the DLT VS160 drive. The DLTape VS1 media can be read by the SDLT 600, thus providing a long-term upgrade solution when customers outgrow the DLT VS160. The DLT VS160 Tape drive requires a unique DLTtape VS1 cleaning cartridge.

The SDLT-1 and SDLT-2 drives use Type 1 SDLT media (also referred to as Compact 5 media) and cleaning cartridges. The SDLT600 drives have been introduced with Type II SDLT media and use the same cleaning cartridges as Type I media.

The following is the compatibility matrix for these HP media types:

| Description | Product no. | DLT 30 (DLT2000XT) | DLT 40 (DLT4000) | DLT 70 (DLT7000) | DLT 80 (DLT8000) | DLT 1 | DLT VS80 | DLT VS160 | SDLT-220 | SDLT-320 | SDLT-600 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| HP DLT tape IV Data Cartridge 40/70/80 GB* | C5141F | N/C | R/W | R/W | R/W | R/W | R/W | R only | R only** | R only** | N/C |
| HP DLT tape IIIXT Data Cartridge 30 GB* | C5141A | R/W | R/W | R/W | R/W | R/W | N/C | N/C | N/C | N/C | N/C |
| HP DLT Cleaning Cartridge | C5142A | C | C | C | C | N/C | N/C | N/C | N/C | N/C | N/C |
| HP DLT VS/DLT1e Cleaning Cartridge | C7998A | N/C | N/C | N/C | N/C | C | C | N/C | N/C | N/C | N/C |
| HP DLTtape VS1 160 GB* Data Cartridge | C8007A | N/C | N/C | N/C | N/C | N/C | N/C | R/W | N/C | N/C | R only |
| HP DLT VS160 Cleaning Cartridge | C8016A | N/C | N/C | N/C | N/C | N/C | N/C | C | N/C | N/C | N/C |
| HP SDLT 220-320 GB* tape Cartridge | C7980A | N/C | N/C | N/C | N/C | N/C | N/C | N/C | R/W*** | R/W*** | R only |
| HP SDLT Cleaning Cartridge | C7982A | N/C | N/C | N/C | N/C | N/C | N/C | N/C | C | C | C |
| HP SDLT II 600 GB* Data Cartridge | Q2020A | N/C | N/C | N/C | N/C | N/C | N/C | R only | N/C | N/C | R/W |

*N/C = Not Compatible, C = Cleaning, R/W = Read and Write compatible*

*\*2:1 Compressed Data Capacities*

*\*\* Most SDLT drives, and all from HP (excluding the SDLT-600), are capable of reading Type IV media written by DLT drives.*

*\*\*\* SDLT-320 drives can read tapes formatted on an SDLT-220 drive. However, SDLT-220 drives cannot read tapes formatted on an SDLT-320 drive.*

The following table provides additional data about DLT, VS160, and SDLT tape cartridges.

**Note:**
All capacities are 2:1 compressed capacities.

| DLT Tape Media / Formatted Capacity | IIIXT | IV | VS160 | SDLT Type I | SDLT Type II |
|---|---|---|---|---|---|
| DLT30 (DLT 2000XT) | 30 GB | NA | N/A | N/A | N/A |
| DLT40 (DLT 4000) | 30 GB | 40 GB | N/A | N/A | N/A |
| DLT70 (DLT 7000) | 30 GB | 70 GB | N/A | N/A | N/A |
| DLT80 (DLT 8000) | 30 GB | 80 GB | N/A | N/A | N/A |
| DLT1 | 30 GB | 80 GB | N/A | N/A | N/A |
| DTL VS160 | N/A | N/A | 160 GB | N/A | N/A |
| SDLT 220/320 | N/A | N/A | N/A | 220/320 GB | N/A |
| SDLT 600 | N/A | N/A | N/A | N/A | 600 GB |
| Tape length (feet) | 1828 | 1828 | 1847 | 1833 | 2066 |
| Cartridge Color | White | Black | Ivory/Black | Green | Blue |

DLT type bar code labels are six or seven characters long. In either case, the first six characters are referred to as the volume identifier. If present, the seventh character is referred to as the media identifier. Some eight character DLT labels may be encountered for SDLT media. In this case, there are two media identifier characters. Only the capital letters A through Z are allowed along with the numbers 0 through 9. All other conventions of the ANSI specification are used including the asterisk for start and stop characters. No checksum digit is used.

**DLT1 and VS80 bar code label format**

Bar code labels for Type IV media used in DLT1 and VS80 drives typically use seven characters. The HP convention calls for the first two characters to be alpha characters, and the next four characters to be numeric. The seventh character must be a *B*. The full description of the format for these cartridges is as follows:

- The six volume characters consist of alphanumeric characters (A-Z) and (0-9) in any order with the exception that the combinations of *CLN* and *DG(space)* shall not be used as normal volume identifiers.

- The seventh character shall be a *B*.

**DLT bar code label format**

Type IV media used in DLT drives typically use either six- or seven-character labels. Much of the early media used only six characters consisting of any combination of alpha and numeric characters. Later, the addition of the seventh character *D* was added as a descriptor by some automation manufacturers to distinguish it from the media used in DLT1 and VS80 drives. Furthermore, the addition of an *E* as the seventh character was added by some automation vendors. One vendor (STK) uses the *E* to distinguish Type III media (without respect to the format) from Type IV media. Another vendor (ATL) uses the *E* to distinguish Type IV media (without respect to the format) from Type III media. *These two conventions conflict with each other.* For cleaning cartridges and diagnostic cartridges, some libraries use a *C* as the seventh character. For most HP libraries, the six-character label format is used. Some exceptions for compatibility are noted in the "Interchange compatibility of labels" section.

The full description of the format for DLT cartridges is as follows:

- The six volume characters consist of alphanumeric characters (A-Z) and (0-9) in any order, with the exception that the combinations of *CLN* and *DG(space)* shall not be used as normal volume identifiers.

- The seventh character shall either be non-existent, *D, C* or *E*.

**SDLT bar code label format**

SDLT media used in both SDLT I (220 GB and 320 GB) and SDLT II (600 GB) drives typically use either seven- or eight-character labels. The label format is the same as other DLT media types, with the exception that the media identifier may either be *S, S1, S2,* or *S3*. HP and other automation vendors use only the *S* identifier, whereas Quantum recommends the use of *S1, S2,* and *S3* identifiers. Because of the limited size of the label, the use of eight-character labels is discouraged for interchange with multiple types of libraries.

# Interchange compatibility of labels

There are some known issues of compatibility with label types not related to the label format. While good quality labels are a necessary first step in assuring reliable bar code reading, there are other factors. Also, be aware that just because a label works in one library, that is no guarantee that label will work in that library the next time. It also does not guarantee that the label will work in another library of the same model, or that the label can be interchanged with other library types. Only through the diligent use of labels from approved suppliers, and with the correct format for the library, will bar code reading be successful and reliable.

The following are some guidelines to follow with respect to label compatibility:

- DLT labels with more than seven characters may have problems in some libraries because of the increased density of the bars and spaces. It is suggested that no more than seven characters be used for DLT labels to ensure compatibility.
- LTO labels that have only one bar code may not be readable in some older HP libraries. Always use the HP dual bar code label from an approved vendor for LTO Generation 1 and 2 type media.
- LTO labels with more or less than eight characters may have problems in some libraries. The length of the label and the location of the media identifiers are critical. It is suggested that exactly eight-character bar codes be used for LTO to ensure compatibility. Bar code reporting structures can be modified on most HP libraries. For information on specific libraries, see the "Tape library and tape autoloader usage of bar code label information" section.
- Some older libraries, such as the Compaq ESL9198 and ESL9326 with laser scanners, may in rare occurrences operate more reliably using thermal transfer labels than with laser/laminate labels. All other current libraries have been qualified with the laser/laminate label.

## Tape library and tape autoloader usage of bar code label information

Some HP libraries interpret the format of the bar code label and will not load tapes to drives that are incompatible. Other HP libraries simply pass the bar code information on to the application software and allow the application to determine whether a move command should be issued. This section describes the operation pre-merger HP and Compaq tape libraries, obsolete tape libraries, and current HP tape libraries. Where appropriate, both Compaq and HP model numbers are given.

**Note:**
The following discussion assumes tapes are labeled correctly. For example, a cleaning cartridge label is not applied to a data cartridge, or an LTO label is not applied to a DLT cartridge. Such mislabeling can lead to possible damage to the cartridge, drives, or library robotics, and cause application problems.

### HP products

**HP StorageWorks 6000 Virtual Library systems**

With the HP VLS6000-series virtual library, bar code templates are created for use with the virtual cartridges on which data is stored. These bar codes can have as few as two characters or as many as 99, and they are completely configurable by the administrator.

When configuring the bar code templates, care should be taken to follow the requirements (if any) for bar code prefixes and length per the backup application. In addition, it is a good idea to use a bar code prefix that differs from any physical cartridge bar codes in a tape library to which data may be migrated behind the VLS. That way, physical and virtual cartridges can be easily recognized from within the backup application.

**HP StorageWorks ESL E-Series Tape Libraries**

The HP StorageWorks ESL E-Series libraries (ESL 712e/322e and ESL 630e/286e), as well as the ESL9322 and ESL9595 (also sold as Compaq models of the same names), do interpret the information. The seventh character, the media identifier, is interpreted as follows:

- *S* indicates an SDLT tape
- *L* indicates an LTO tape
- Any other identifier, or no identifier, indicates a DLT tape

A problem occurs if the seventh character is a *C* as required for some LTO libraries. The *C* is interpreted as a DLT cartridge even though it is an LTO cartridge. LTO cleaning cartridges for ESL libraries should use the L media identifier as the seventh character.

The use model for ESL libraries is that only data tapes with labels that contain media identifiers compatible with the target drive are allowed library access to that drive. For example, an LTO cartridge with a media identifier of *L1* is not allowed to be moved into a DLT drive. In general, the drive that is the target of the move must be able to perform a valid operation on that tape, either a read, write, or clean. An exception is if the media identifier for an SDLT tape is *S* only, it is allowed to be moved into either an SDLT-1 or an SDLT-2 drive. If the tape was actually written in an SDLT-2 drive and the target is an SDLT-1 drive, an error occurs at the application level. No damage will occur to the tape or the drive. By default, the ESL libraries display only the first six characters of the bar code label on the user GUI screen. This may be altered by service personnel only. As a default, the ESL libraries report only the first six characters to the application. The number of characters reported on the screen can be changed using the front panel interface. The number of characters reported to the host can only be changed using the serial port and software. In all cases, the leading or left-justified characters are displayed or reported. This justification cannot be altered.

**HP StorageWorks Enterprise Modular Library (EML) E-Series Tape Libraries**

The EML Tape Libraries bar code reporting can be configured as six to eight characters and left or right aligned. If six characters with left alignment is chosen, any characters after the sixth are truncated. With six characters and right alignment, only the last six characters are shown with the beginning characters truncated.

The LTO labels have *L1*, *L2*, and *L3* as the media identifiers for the respective LTO1, LTO2, and LTO3 cartridges. All cleaning cartridges should use the format *CLNxxxL1* type of label, where *xxx* is a number between 000 and 999 for all types of LTO drives. WORM tape cartridges for LTO3 have media identifiers of *LT*. The length and justification of the bar code reporting format, as sent to the host and as viewed on the front panel, may be configured through the front panel configuration section.

The HP MSL series of libraries, also sold as Compaq MSL models, do not interpret the bar code label information. The type of cartridge, DLT or LTO, is identified by the magazine where it resides. If the magazine type is of the same class as the drive, the move will be attempted, independent of the bar code information. For example, if an SDLT cartridge is placed in a DLT library, the robot will attempt to place the cartridge in the drive. When the move fails (SDLT tapes do not fit into DLT drives) the cartridge is returned to the magazine slot it came from and an error message is reported.

The MSL reports all bar code characters (up to eight) to the host. Eight is the default. The user can reduce this number using the service level of the front panel, or by using the `MSL5000util.exe` utility and the serial port that is shipped with the library. Also, the user may change the left or right justification of the bar code. For example, a library set for six characters and right justification would report a label of ABC123L1 as C123L1 to the host. This example is not typical. Most applications examine all the characters or the first six characters.

The HP StorageWorks 1/16 Tape Superloader has an optional bar code reader. The Superloader does not interpret the bar code reader information.

HP StorageWorks 1/8 autoloader does not have a bar code reader.

## Obsolete HP products

- HP models 4215, 7215, 4228, 4248, 4448, 7228, 7248, and 7448 do not interpret the bar code label information. These are DLT-only libraries. The label contents are passed on to the host application as they are read. A maximum of six characters are passed to the host. These are the first six characters (as a human would read them, left to right) of the label.

- HP models A4825-252/400/588 and A4846-100 do interpret the contents of the bar code label. These DLT-based libraries require the seventh character of the cleaning cartridge to be a *C* when a cleaning operation is initiated with that cartridge.

- HP SureStore models 1/20 through 10/100 and HP SureStore 1/9 models do not interpret the contents of the bar code label. However, these models have a setting that determines how many characters the library sends to the host. The possible settings are for six, seven, or eight maximum characters to be sent to the host. For example, an LTO library that is set to six characters maximum, reading an eight character label of *AB1234L1* would not send the *L1* media identifier. It would send only the volume label of the first six characters: *AB1234*. For some host applications, this setting is significant. See the "ISV software application needs and usage of bar code label information" section. These models require the use of the HP dual bar code LTO labels.

- HP SureStore 3/30, 6/100 and 10/588 libraries do not interpret the bar code label information. These libraries were only available with DLT4000 or DLT7000 drives. The interpretation of the bar code information is the same as described for the 10/180 and 20/700 models below for the identifiers *C*, *D*, *E*, and *R*. Other identifiers are unknown to these libraries.

- HP SureStore models 10/180 and 20/700 do interpret the information on the bar code label. The media identifier, the seventh bar code character, is interpreted as follows:
  - *C* indicates a DLT CompacTape III or a DLT cleaning cartridge.
  - *D* indicates a DLT CompacTape IV cartridge.
  - *E* indicates a DLT CompacTape III XT cartridge.
  - *R* indicates a standard 9840 cartridge.
  - *L* indicates an LTO cartridge.

- Compaq model TL891 series libraries do not interpret the bar code label information. Bar code reporting format length and justification can be set through the front panel.

- Compaq model TL895 series libraries do not interpret the bar code label information. Bar code reporting format length and justification can be set through the front panel.

- Compaq model SSL2020 AIT libraries do not interpret the bar code label information. The label for this product that is shipped with the library contains a checksum digit.

- HP StorageWorks AIT 35 GB autoloader does not have a bar code reader. The label for this product that is shipped with the library contains a checksum digit.

# ISV software application needs and usage of bar code label information

Some of the more commonly used ISV applications for tape libraries are listed below. Each may use and interpret the information the library communicates about the bar code label differently. It is critical that the requirements of the ISV application be understood and the label format and library configuration be set to meet those requirements.

## HP OpenView Storage Data Protector

- The application interprets all characters returned by the library.
- The number of characters interpreted by the application cannot be configured.
- The application ignores the media identifiers (for example, *L1*) on LTO generation 1 labels.
- Data Protector assumes that a tape beginning with *CLN* is a cleaning tape.
- Data Protector views the bar code label as a soft reference to the tape. If the bar codes of two tapes are swapped, Data Protector does not know the difference until the tapes are used and the header is read (scan, backup, restore, etc.). When Data Protector identifies each tape, it also associates the proper bar code with each tape.

## Symantec NetBackup

- NetBackup reads the full bar code (up to 16 characters) and create a six-character media ID. The media ID defaults to the last six characters of the bar code unless a media generation rule is set to choose the desired characters for the media ID.
- Any six characters can be configured for the media ID, but the default is the last six characters. Be aware, however, that this may cause problems if left in this mode for LTO. In the case of LTO, the first six characters are unique, and the last two are the media identifiers.
- Using media ID generation rules allows you to override the default media ID naming method used by Media Manager. To set these rules via the GUI, select **Robot Inventory > Advanced Options > Media ID Generation**, or add the following line to the `[install_path]/volmgr/vm.conf` file:

  ```
  MEDIA_ID_BARCODE_CHARS = <robotnum> <barcode_length> <c1>:<c2>:<c3>:<c4>:<c5>:<c6>
  ```

  Where:
  – *<robotnum>* is typically always 0
  – *<barcode_length>* is the bar code length
  – $<c1>:<c2>:<c3>:<c4>:<c5>:<c6>$ are the six characters to use for the Media ID

  For example, the following line sets a rule for robot 0 to use the first six characters of an eight-character bar code as the Media ID:

  ```
  MEDIA_ID_BARCODE_CHARS = 0 8 1:2:3:4:5:6
  ```

- LTO drives use eight-character bar codes. The last two digits identify the generation of the drive (L1, L2, or L3). NetBackup can only read six-character bar codes. If you choose to read the right six characters (the default setting), you could potentially have duplicate media IDs. If you choose to read the left six characters, then the characters that identify the generation are truncated. In this case, the only solution is to purchase labels and apply them to the cartridges in such a way that the first character or characters are unique to each generation of tape.

## Symantec Backup Exec

- All characters are interpreted from the library.
- The number of characters interpreted cannot be configured.
- If the application is configured to use bar code rules, then the media identifier (bar code) can be used to select the correct type of media to be mounted into a drive in a mixed media library.
- The application only uses the bar code for the purpose of locating the media within the library. The media header is always read when the media is mounted into a drive.

## Computer Associates BrightStor ARCserve

- 32 bytes can be read from the library.
- No configuration of the number of bytes read by the application is possible.
- 32 bytes are always allocated, but ending space characters are ignored.
- The media identifier is treated as a string of characters. If the leading character is a space character or \0, the slot is considered full, but to have no bar code. If it is a space, ARCserve assumes it has a bar code that is a blank. If the first character is a NULL character, ARCserve assumes that there is no bar code. However, ARCserve does not depend on the bar code to determine if a slot is full or not. ARCserve looks at the information from the read element stat to determine if the slot is full or not.
- The medium label has to be unique and cannot be reused. For example, if a user reuses or moves a used bar code to a new cleaning tape, ARCserve considers the new cleaning tape to be an old one and rejects it.

## EMC Legato Networker

- Networker collects and saves up to 35 characters of a volume tag. Networker does not currently use the bar code as anything other than a text-string identifier for a tape.
- No configuration of the number of bytes read by the application is possible.
- Networker does not interpret the bar code information.
- Bar codes are used simply as machine readable labels. The content is not examined in any manner. NetWorker only performs string comparisons to see if the volume is the desired one.

## IBM Tivoli Storage Manager

- Tivoli Storage Manager (TSM) interprets all the characters sent by the library.
- The number of characters interpreted cannot be configured.
- TSM interprets characters as an internal name and uses them as a volume name.
- TSM does not interpret media identifier characters.
- If TSM cannot read the bar code, it will not perform the labeling.

# HP recommended bar code labels, formats and usage

HP recommends that bar code labels only be purchased from HP and approved suppliers. For more information on HP product offerings, go to http://www.hp.com/go/storagemedia. The labels produced by EDP Tri-Optic® have been tested and referenced the most by HP for LTO/Ultrium- and DLT-type compatible labels. For more information on EDP Tri-Optic offerings go to http://www.tri-optic.com.

Labels that are shipped with HP libraries and labels bought through HP after the initial purchase are uniquely sequenced labels. The sequence from the manufacturer only repeats when all possible combinations are exhausted. For LTO this will take over 5 million labels to begin at AA0001L1 again. LTO Gen 1 and LTO Gen 2 labels are unique to each other in this same manner (because some applications only regard the first six characters, and some libraries may mix Gen 1 and Gen 2 drives). Customers who are concerned about receiving unique labels can feel secure in ordering labels through HP and do not have to order custom labels sequences to ensure unique labels.

The HP recommended formats for each technology are:

| Drive Type | Data Cartridge | Cleaning Cartridge | Diagnostic Cartridge |
|---|---|---|---|
| DLT1 and VS80 | nnnnnnB | CLNnnnC or CLNnnn | DG nnnC |
| DLT (type IV media) | nnnnnn | CLNnnnC or CLNnnn | DG nnnC |
| SDLT-I, II | nnnnnnS | CLNnnnS | DG nnnS |
| LTO Gen 1 | nnnnnnL1 | CLNvnnL1* or CLNvnnCU | DG vnnL1 |
| LTO Gen 2 | nnnnnnL2 | CLNvnnL1* or CLNvnnCU | DG vnnL2 |
| LTO Gen 3 | nnnnnnL3 nnnnnnLT | CLNvnnL1* | DG vnnL3 DG vnnLT |

In the above table, *nnnnnn* represents any combination of alpha and numeric characters (capital letters A through Z and numbers 0 through 9) except for those specifically reserved for other uses (such as *CLN* and *DG*). *v* represents a vendor ID character. Note the space character after *DG* for diagnostic cartridges. See the specification for each label for a more detailed description of special cases.

**\* Note:**
For ESL libraries, the LTO cleaning cartridges must be of the form *CLNvnnL1*. For HP SureStore 10/180 and 20/700 libraries, the LTO cleaning cartridges must be of the form *CLNvnnCU*. The actual cleaning cartridge is the same for Gen 1, Gen 2, and Gen 3 LTO products. The same cartridge cleans all generations of LTO drives. For all HP libraries and all generations of Ultrium drives, the LTO Gen 1 cleaning cartridge is used. It should have the label format *CLNxxxL1*.

# Potential issues caused by the improper use of bar code labels

- Labels of the wrong media can potentially cause damage to the cartridge, the drive, or the library. Some cartridges do not fit into drives of a different type. For example, damage may occur if an LTO cartridge is labeled as a DLT cartridge and a command is sent to insert that cartridge into a DLT drive.
- Tapes labeled with the wrong media identifier may be prevented from being inserted into a drive by the library or the ISV application.
- Cleaning cartridges that are not labeled as cleaning cartridges may be prevented from being used in a cleaning operation.
- Data cartridges labeled as cleaning cartridges may be inserted in a drive for a cleaning operation, but the cleaning will not be possible.
- Disoriented labels on the cartridges may fall off the cartridge or become jammed in the drive and cause a drive failure.
- Disoriented labels may be read by some libraries in some locations but not by all libraries or in all slot locations.
- Labels placed anywhere but the location of the cartridge specifically designed for them may become jammed in the drive and cause a drive failure.
- Labels with more characters than recommended may lead to inconsistent ability to read the label.

# DOs and DON'Ts of bar code labels

- DO purchase labels only from HP or HP-approved suppliers.
- DO use LTO labels within one year of receiving them. The adhesive loses effectiveness while on the shipping paper. After being placed on the LTO cartridge, there is no degradation of the adhesive properties.
- DO replace damaged labels on tapes. If the exact character sequence is required, it can be ordered through EDP Tri-Optic®. For more information, see http://www.tri-optic.com.
- DO orient labels correctly, especially LTO labels.
- DO understand the requirements of your software application for bar code labels.
- DO configure your library, as far as possible, to work most effectively with your labels and your software application.
- DO use only the recommended format for the tape label information.
- DO use the proper bar code label for the appropriate type of media. For example, use AIT labels on AIT cartridges and LTO labels on LTO cartridges.
- DO use unique bar code identifiers for virtual cartridges in a VLS unit to distinguish them from physical media.
- DON'T print labels on personal printers.
- DON'T place the label anywhere except in the approved area of the cartridge.
- DON'T write on the bar code label.
- DON'T apply new labels over existing labels on a cartridge. Remove the existing label before adding a new label.
- DON'T re-use LTO labels. When an LTO label is removed from a cartridge, the adhesive is not capable of reliably holding the label to a cartridge again.
- DON'T use other adhesives, such as tape, to attach a label to a cartridge. The reflectivity of the tape will interfere with the ability of the scanner to read the label.

## Conclusion

Using bar code labels on tape cartridges can increase the productivity of an overall tape management system. Tracking cartridges by bar code information within the library and outside of the library can have many benefits. Taking a few simple steps can enable the user to consistently realize the advantages of the bar code system. The labels must be of high quality, preferably purchased through HP or HP qualified sources. The format of the label must be correct for the tape technology and library systems being used. The library must be configured in conjunction with the requirements of the ISV software application. And finally, the ISV software application must be configured for the bar code labels being used. By following these guidelines, the bar code system will operate effectively and reliably resulting in a highly successful tape management system.

## For more information

http://www.hp.com/go/ebs