IBM System Storage TS3100 Tape Library

The TS3100 Tape Library (Machine Type 3573, Model L2U) is a single or dual drive entry level desktop or a rack-mounted unit (requiring two rack units of an industry standard 19-inch rack) that can operate in random or sequential mode. The robotics inside the library move the cartridges to and from the tape drive permitting unattended backup. Two removable magazines can store a total of 24 cartridges. A single dedicated mail slot (I/O station) is available for importing and exporting cartridges.

The following IBM Ultrium Tape Drives are available for the TS3100 Tape Library:

- The IBM Ultrium 4 Low Voltage Differential (LVD) SCSI Tape Drive
- The IBM Ultrium 4 Fibre Channel (FC) Tape Drive
- The IBM Ultrium 4 Serial Attached SCSI (SAS) Tape Drive
- The IBM Ultrium 3 Half-High LVD SCSI Tape Drive
- The IBM Ultrium 3 Half-High SAS Tape Drive
- The IBM Ultrium 3 Full-High LVD SCSI Tape Drive
- The IBM Ultrium 3 Full-High FC Tape Drive

Up to two IBM Ultrium 3 or 4 Half-High Tape Drives or one IBM Ultrium 3 or 4 Full-High Tape Drive can be installed in the TS3100 Tape Library.

Tape Encryption is supported on the IBM Ultrium LTO4 Tape Drive with the SAS and Fibre Channel interface. The TS3100 supports Application-Managed Encryption, and System-Managed Encryption as well as Library-Managed Encryption (refer to Feature code 5900, Transparent LTO Encryption).

The TS3100 Tape Library has four indicator LEDs and one Liquid Crystal Display (LCD) on the front. The LEDs can be used to indicate Ready/Activity, Use Cleaning Tape, Media Attention, and Error.

Standard features are a barcode reader and a remote management unit (RMU). We use the terms RMU and Web interface interchangeably throughout the following chapters.

New in 2007, the TS3100 is now Simple Network Management Protocol (SNMP) capable.
8.1 Description

Designed for tape automation, the TS3100 Tape Library can be attached to IBM System i or i5, iSeries, AS/400, IBM System p or p5, pSeries, RS/6000, IBM z or z9, xSeries, Hewlett-Packard (HP), Sun, UNIX, and PC servers. To determine the latest supported servers, visit the Web at:

http://www-03.ibm.com/systems/storage/tape/

The IBM Ultrium 4 LTO Tape Drive with a Fibre Channel or a SAS interface is encryption capable. The IBM LTO4 Tape Drive supports Application-Managed Encryption (AME), System-Managed Encryption (SME), and Library-Managed Encryption (LME). The TS3100 supported encryption methods are AME, SME, and LME.

Depending on what IBM Ultrium Tape Drive is installed in the TS3100 Tape Library, the following Data Cartridges can be used:

- The TS3100 Tape Library uses the IBM TotalStorage LTO Ultrium 400 GB Data Cartridge or the 400 GB WORM cartridge when the IBM Ultrium 3 Tape Drive is installed. The Ultrium 3 Tape Drive has the capability of writing up to 400 GB native capacity and up to 800 GB with 2:1 compression. IBM Ultrium 3 Tape Drives can read and write LTO Ultrium 2 Data Cartridges and read LTO1 data cartridges.

- The TS3100 Tape Library uses the IBM TotalStorage LTO Ultrium 800 GB Data Cartridge or 800 GB WORM Cartridge when the IBM Ultrium 4 Tape Drive is installed. The Ultrium 4 Tape Drive has the capability of writing up to 800 GB native capacity and up to 1600 GB with 2:1 compression. IBM Ultrium 4 Tape Drives can read and write LTO Ultrium 3 Data Cartridges, can read Ultrium 2 Data Cartridges, and does not support Ultrium 1 Data Cartridges.

The library capacity is 24 tape cartridges, providing a media capacity of up to 9.6 TB (19.2 TB with 2:1 compression) data storage per TS3100. See Table 8-1 for additional information.

Table 8-1 Library storage capacity and data transfer rate

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>2U Library Specification</th>
</tr>
</thead>
</table>
| Maximum storage capacity - Ultrium 4 Data Cartridges | 24 data cartridges  
  ▶ Native: 19.2 TB  
  ▶ Compressed: 38.4 TB (2:1 compression) |
| Maximum storage capacity - Ultrium 3 Data Cartridges | 24 data cartridges  
  ▶ Native: 9.6 TB  
  ▶ Compressed: 19.2 TB (2:1 compression) |
| Maximum data transfer rate | Native: 80 MB/s (288 GB/hr.)  
  ▶ Compressed: 160 MB/s (576 GB/hr.) (2:1 compression) |

Depending on the way the TS3100 is ordered, you specify the required drives through feature codes or through the model number. For the IBM 3573-L2u, you can use these drive feature codes:

- FC8043 Ultrium 3 LVD SCSI Tape Drive Sled
- FC8044 Ultrium 3 4Gb/s Fibre Channel Tape Drive Sled
- FC8046 Ultrium 3 Half-High SCSI Tape Drive Sled
- FC8047 Ultrium 3 Half-High SAS Tape Drive Sled
- FC8143 Ultrium 4 SCSI Tape Drive Sled
- FC8144 Ultrium 4 Fibre Tape Drive Sled
FC8145 Ultrium 4 SAS Tape Drive Sled
FC8147 Ultrium 4 Half-High SAS Tape Drive Sled

Via type-model-feature (TMF) through System x order entry, seven models are available for the TS3100 Tape Library:

- The 3573-L4S comes with an IBM Ultrium 4 LVD SCSI Tape Drive. The Ultrium 4 LVD SCSI drive has an LVD Ultra 160 SCSI interface that can be connected to LVD fast/wide adapters. The Ultrium 4 Tape Drive provides a sustained native data transfer rate of 120 MB/s.
- The 3573-F4S comes with an Ultrium 4 Tape Drive with a 4 Gbps Fibre Channel interface. The Ultrium 4 Tape Drive provides a sustained native data transfer rate of 120 MB/s.
- The 3573-S4S comes with a SAS Ultrium 4 Tape Drive that has a SAS interface, which has a native data transfer rate of up to 3 Gbps. The SAS Ultrium 4 Tape Drive comes with an SFF-8088 interface. The Ultrium 4 Tape Drive provides a sustained native data transfer rate of 120 MB/s.
- The 3573-L32 comes with a Half-High Ultrium 3 LVD SCSI Tape Drive. The Ultrium 3 LVD SCSI Tape Drive has an LVD Ultra 160 SCSI interface. The Half-High Ultrium 3 Tape Drive provides a sustained native data transfer rate of 60 MB/s.
- The 3573-S32 comes with a Half-High Ultrium 3 SAS Tape Drive. The Half-High Ultrium 3 Tape Drive has a maximum native data transfer rate of up to 60 MB/s.
- The 3573-F3S comes with a Full-High Ultrium 3 native switched 4 Gbps Fibre Channel Tape Drive. The Full-High Ultrium 3 Tape Drive has a maximum native data transfer rate of up to 80 MB/s.
- The 3573-L3S comes with a Full-High Ultrium 3 LVD SCSI Tape Drive. The Full-High Ultrium 3 Tape Drive has a maximum native data transfer rate of up to 80 MB/s.

Figure 8-1 shows the front view of the TS3100 Tape Library. On the left and right sides, you see the cartridge magazines. The I/O slot is accessible from the lower left.

8.2 Components

The IBM TS3100 Tape Library has an improved robotic system that moves along an axis from front to back between the two cartridge magazines. This limited movement provides robust robotics. The standard barcode reader is installed on the picker.

Figure 8-2 on page 188 shows the top view of the TS3100 Tape Library. The right side of the image is the rear of the library and the left side is the front of the TS3100 Tape Library. The TS3100 Tape Library is a modular system, allowing the client to change parts easily.
The components shown in Figure 8-2 are:

1. **Right cartridge magazine** - This magazine can hold up to twelve cartridges.
2. **Left cartridge magazine** - This magazine can hold up to 12 cartridges and houses the I/O station.
3. **Accessor** - This component contains the library robot and the barcode reader. The accessor moves cartridges to and from the:
   - I/O station
   - Storage slots
   - Tape drive
4. **Library control card** - This component is a customer-replaceable unit (CRU) and stores the user configuration information or vital product data (VPD). The RMU is embedded in this card.
5. **Tape drive sled** - This library supports the Ultrium 3 or Ultrium 4 tape drive. The tape drive in the library is packaged in a container called a *drive sled*. The drive sled is a CRU, and it is designed for easy removal and replacement.
6. **Power supply** - The power supply is a CRU. No redundant power is available.

### 8.2.1 Operator Control Panel

The library is equipped with an Operator Control Panel (OCP). By means of the OCP a user can perform simple actions with the media changer. The OCP interface allows a user to monitor the media changer operation, make configuration changes and perform media access commands. For an extensive description of the OCP functions please refer to the OCP specification in *IBM System Storage TS3100 Tape Library and TS3200 Tape Library: Setup, Operator, and Service Guide*, GA35-0545.
8.2.2 Robotics

The IBM TS3100 Tape Library uses a new independent tape loader, threader motors, and a positive pin retention. These are designed to help improve the reliability of loading and unloading a cartridge and to retain the pin even if tension is dropped. An independent loader motor coupled with the positive pin retention is designed to thread the tape with a higher level of reliability.

8.2.3 Barcode reader

The barcode reader is an integral part of the library accessor, and it does not affect the slot capacity. The barcode reader provides inventory feedback to the host application, Operator Control Panel display, and Web User Interface by reading cartridge barcode labels. The library stores the customized inventory data in memory.

8.2.4 Remote management

The Remote Management Unit (RMU) provides remote management to the library over a network. This function is imbedded in the Library Control Card. The library can be attached to the network using the 10/100 MB Ethernet port. The Ethernet connection is located on the back of the library.

When the IP address is set on the library using the Operator Control Panel (OCP), the library can be monitored and controlled remotely. Entering the IP address in a browser opens a graphical representation of the library. Service actions, such as upgrading the library and drive firmware, can be done by using the remote management facility. Figure 8-3 on page 190 shows the home page of the Web User Interface.

Note: When a user executes a medium access command through the OCP interface the media changer will enter the off-line state. When the media changer is off-line the media changer will report Not Ready on the SCSI bus.
8.3 Cartridge storage

The IBM TS3100 Tape Library has two removable magazines in the library. The total number of cartridges is 24. The right magazine and the left cartridges magazine can hold up to 12 cartridges per magazine.

The native maximum storage capacity is 19.2 TB with the IBM Ultrium 4 Tape Drive and 9.6 TB with the IBM Ultrium 3 Tape Drive installed. The Input/Output station (or "mail slot") is part of the left magazine. The magazines can be released using the Operator Panel or the Web User Interface. Magazine access is password-protected.

Figure 8-4 on page 191 shows the right magazine.
When the magazines are filled with cartridges, you can use the Web User Interface to see which cartridges are stored in which storage slot location as demonstrated in Figure 8-5.

Part of the left magazine is the I/O station. You can use the Web User Interface to show an inventory of the magazine as shown in Figure 8-6 on page 192.
Figure 8-6  Inventory of the left magazine using the Web User Interface

Figure 8-7 shows the left magazine with the I/O station on the left side.

Figure 8-7  Left magazine

The I/O station is part of the left magazine. In Figure 8-8 on page 193, you can see the left magazine with the I/O slot opened. You can open the I/O station using the OCP or the Control Menu from the Web user Interface. Magazine access is password-protected.
8.4 LTO Ultrium Tape Drives

This library supports the Ultrium 3 and Ultrium 4 Tape Drives. Each tape drive in the library is packaged in a container called a drive sled. The drive sled is a customer replaceable unit (CRU), and is designed for quick removal and replacement in the library. In the following section we summarize the characteristics of the LTO4 and LTO3 Full-High and Half-High Tape Drives.

The Ultrium 4 Full High Tape Drive supports:
- LVD Ultra160 with two HD68 connectors
- Serial Attached SCSI (SAS) with two SFF-8088 SAS connectors
- Fibre Channel interfaces, with one LC Fibre Channel connector

The Ultrium 4 Half High Tape Drive supports only one SAS SFF-8088 connector.

The Ultrium 3 Full High Tape Drive supports:
- LVD Ultra160 with two HD68 connectors
- Fibre Channel interfaces with one LC Fibre Channel connector

The Ultrium 3 Half High Drive supports:
- Serial Attached SCSI (SAS) with one SFF-8088 SAS connector
- LVD Ultra160 with two HD68 connectors

For additional details on LTO4 and LTO4 Tape Drives refer to “Overview of IBM LTO Ultrium Tape Drives” on page 29.

8.4.1 IBM Ultrium LTO4 Tape Drive

Each IBM Ultrium 4 Tape Drive contains the electronics and logic for reading and writing data, controlling the tape drive, managing the data buffer, and handling error recovery procedures. Because of its special design as a CRU, the drive can easily be replaced if necessary. Figure 8-9 on page 194 shows the Ultrium 4 drive sled with a SCSI interface. The same drive sled can also contain the 4 Gbps Fibre Channel drive or the SAS drive. For additional details refer to “IBM LTO4 Full-High (FH) Tape Drive” on page 75 and to “IBM LTO4 Half-High (HH) Tape Drive” on page 76.
Figure 8-9  Library drive sled with an Ultrium 4 SCSI Tape Drive

Servo and track layout technology
There are 896 data tracks in Ultrium 4 versus 704 data tracks in Ultrium 3, used to read and write data to the data cartridge. These tracks are grouped in five servo bands as explained in “Servo tracks” on page 35. The high-bandwidth servo system features a low-mass servo to help more effectively track servo bands and improve data throughput with damaged media in less-than-optimal shock and vibration environments.

Speed matching
To improve the performance of the LTO4 Tape Drive, the Tape drive uses a technique called speed matching to dynamically adjust its native (uncompressed) data rate to the slower rate of the server’s host bus adapter (HBA). The LTO4 Tape Drive is negotiating with the server’s HBA, setting up a speed with the best performance. Six speeds are available when reading or writing the generation 3 or generation 4 cartridge format. Native rates are:

- Generation 3: 30, 40, 50, 60, 70, or 80 MB/s
- Generation 4: 30, 48, 66, 84, 103, or 120 MB/s

If the server is between two of the native rates, the drive calculates the appropriate data rate at which to operate. Speed matching reduces back hitching. Back hitching is the condition that occurs when a data cartridge stops, reverses, and restarts motion. A backhitch is usually the result of a mismatch between the data rates of the connected server and the tape drive.

Surface Control Guiding Mechanism
The IBM patented Surface Control Guiding Mechanism is designed to guide the tape along the tape path in the IBM Ultrium LTO Tape Drives. This method uses the surface of the tape, rather than the edges, to control tape motion. This helps reduce tape damage (especially to the edges of the tape) and tape debris, which comes from the damaged edges and can accumulate in the head area. The Ultrium 3, Ultrium 4, Half-High, and Full-High Tape Drives use Surface Control Guiding Mechanism.

Channel calibration
The channel calibration feature of the Ultrium 4 Tape Drive customizes each Read/Write data channel for optimum performance. The customization enables compensation for variations in the recording channel transfer function, media characteristics, and Read/Write head characteristics.
Magneto resistive head design
Magneto resistive (MR) head design, which uses flat lap head technology in the MR heads for Ultrium 4, helps minimize contact, debris accumulation, and wear on the tape as it moves over the Read/Write heads.

Separate writing of multiple filemarks
Separate writing of multiple filemarks is designed to request any write command of two or more filemarks to cause a separate data set to be written containing all filemarks after the first. This feature has two advantages:

1. It helps improve performance if a subsequent append overwrites somewhere after the first filemark.
2. Write of multiple filemarks typically indicates a point where an append operation might occur after the first of these filemarks.

This change helps prevent having to rewrite data sets containing customer data and the first filemark if such an append occurs.

Sleep mode
To save energy, the LTO4 tape drives use a feature called sleep mode. To enter sleep mode, the LTO4 tape drive must be inactive for a minimum of 30 seconds. The LTO4 tape drive will go out of this sleeping mode again after receiving a SCSI command, a command across the Library/Drive interface (LDI or RS-422), or on a load or unload request. When in sleep mode, the drive response time to commands that do not require media motion increases by up to ten microseconds. Commands that require media motion might be delayed an additional 100 milliseconds, because the tape must be re tensioned.

Statistical Analysis and Reporting System
The Ultrium 4 Half-High and Full-High Tape Drive uses SARS to help isolate failures between media and hardware. The SARS uses the data cartridge performance history saved in the Cartridge Memory (CM) module and the drive performance history kept in the drive flash Electronically Erasable Programmable Read-Only Memory (EEPROM) to help determine the likely cause of the failure. SARS can cause the drive to request a cleaning tape, to mark the media as degraded, and to indicate that the hardware has degraded. When a drive dump is taken from the drive, the Support Center can determine if the failure is in the Tape Drive itself or on the Data Cartridge. SARS is also used in the Ultrium 3 Half-High and Full-High Tape Drive.

8.4.2 IBM Ultrium LTO3 Tape Drive
Here in this section, we describe some of the highlights of the Ultrium 3 Half-High and Full-High Tape Drives. Most of the functions are similar to the Ultrium 4 Half-High and Full-High Tape Drive described in session 8.4.1, “IBM Ultrium LTO4 Tape Drive” on page 193. For additional details related to LTO3 Tape Drive refer to “IBM LTO3 Full-High (FH) Tape Drive” on page 71 and to “IBM LTO3 Half-High (HH) Tape Drive” on page 72.

LTO3 Characteristics
Here we summarize the characteristics of the IBM Ultrium 3 Half-High and Full-High Tape Drive. They are the following:

Servo and track layout technology: The Ultrium 3 Half-High and Full-High Tape Drive use 704 data tracks to read and write data to the data cartridge.

Dynamic speed matching: The Ultrium 3 Tape Drive is designed to perform dynamic speed matching (at one of four speeds of 30, 40, 50, or 60 MB/s) to adjust the
tape drives native data rate as closely as possible to the net host data rate (after data compressibility has been factored out). This helps the number of backhitch repositions and improves throughput performance.

**Surface Control Guiding Mechanism:** This function has been designed to guide the tape along the tape path. This method uses the surface of the tape, rather than the edges, to control the tape motion.

**Channel calibration:** The channel calibration feature of the Ultrium 3 Tape Drive customizes each Read/Write data channel for optimum performance.

**Magneto resistive (MR):** This is a head design which uses flat lap head technology in the MR heads for Ultrium 3.

**Separate writing of multiple filemarks:** This function is designed to request any write command of two or more filemarks to cause a separate data set to be written containing all filemarks after the first.

**Sleep mode:** The Ultrium 3 Half-High and Full-High Tape Drive has a power management function that is designed to control the drive electronics to be either completely turned off or stay in low-power mode when the circuit functions are not needed for drive operation.

**Statistical Analysis and Reporting System (SARS):** The Ultrium 3 Half-High and Full-High Tape Drive use SARS to help isolate failures between the media and the hardware.

### 8.5 Physical attachments

The IBM TS3100 Tape Library is available with three interfaces:

- SCSI Ultra Fast/Wide 160 LVD
- 4 Gbps Native Fibre Channel
- SAS 3 Gbps

#### 8.5.1 SCSI Ultra Fast/Wide 160 LVD

IBM LVD tape devices support a bus length of 25 m (82 ft.) point-to-point and 12 m (39 ft.) using multi-drop interconnection (daisy-chaining). For each daisy-chained device, the maximum cable length must be reduced by 0.5 ms (1.6 ft.).

The Ultrium 3 drive uses shielded, HD68, 68-pin connectors and can attach directly to a 2-byte-wide SCSI cable.

The Ultrium 3 LTO drive provides a sustained native data transfer of 80 MB/s and can store up to 400 GB of uncompressed information on a single data cartridge.

**Note:** A faster bus does not imply that an attached device will support that data rate, but that multiple devices can operate on the bus at the maximum speed. To ensure the best performance, if possible, avoid daisy-chaining.

#### 8.5.2 Fibre Channel interface

Ultrium 3 and 4 Fibre Channel tape drives use LC duplex fiber optic cables. The maximum distances that the library supports on a Fibre Channel link is determined by the link speed, the type of fiber (50-micron or 62.5-micron), and the device to which the library is attached.
If the library attaches to an HBA, refer to the distances that are supported by the HBA. If the library attaches to a switch, the supported distances are:

► For a 50-micron cable:
  – 1 Gbit link speed = up to 500 m (1640 ft.)
  – 2 Gbit link speed = up to 300 m (984 ft.)
  – 4 Gbit link speed = up to 150 m (492 ft.)

► For a 62.5-micron cable:
  – 1 Gbit link speed = 175 m (574 ft.)
  – 2 Gbit speed link = 150 m (492 ft.)
  – 4 Gbit speed link = 70 m (230 ft.)

The 4 Gbps Native Fibre Channel drive port can be configured in the following methods:

► LN Port: (default setting) An automatic configuration that tries arbitrated loop first, then switched fabric

► L Port: Arbitrated loop

► N Port: Point-to-point protocol in a switched fabric topology

### 8.5.3 SAS interface

The SAS interface is new in the IBM Ultrium Tape Drive family and the IBM Ultrium 4 SAS Full-High Tape Drive comes with two SFF-8088 interfaces on the back of the tape drive. The IBM Ultrium 3 SAS Half-High Tape Drive comes with one SAS interface on the back of the drive. For a more detailed description of SAS, see “Serial-Attached SCSI” on page 56.

At the time of writing, two HBAs were supported:

► LSI Logic SAS3800X

► IBM SAS HBA Controller model 25R8060

Figure 8-10 shows the back side of the SAS Full-High Tape Drive with two SFF-8088 interfaces.

Figure 8-10  the back side of the SAS Full-High Tape Drive

Figure 8-11 on page 197 show the back side of the SAS Half-High Tape Drive with one SFF-8088 interface

Figure 8-11  Back side of the SAS Half-High Tape Drive
No terminator is needed, because the SCSI bus is automatically terminated.

### 8.5.4 Persistent binding

When you boot a server, it discovers devices and assigns them SCSI target and LUN IDs. It is possible for these SCSI assignments to change between reboots. Certain operating systems do not guarantee that devices are always allocated the same SCSI target ID after rebooting. Also, some software depends on this association, so you do not want it to change. Persistent binding addresses the issue of SCSI ID assignment.

Persistent binding is an HBA function that allows a subset of discovered targets to be bound between a server and device. Implemented by a worldwide node name (WWNN) or worldwide port name (WWPN), persistent binding causes a tape drive's worldwide name (WWN) to be bound to a specific SCSI target ID.

After a configuration has been set, it survives reboots and any hardware configuration changes because the information is preserved. If a drive needs to be replaced, the new drive assumes the WWNN of the old drive because the WWNN for the drive is location-dependent within the library. Because the WWNN does not change, persistent binding does not need to be changed, which causes an outage.

You can find additional information about persistent binding in *Implementing IBM Tape in UNIX Systems*, SG24-6502, and *Implementing IBM Tape in Linux and Windows*, SG24-6268.

### 8.5.5 Encryption

The LTO Ultrium 4 Tape Drive supports host Application-Managed Encryption (AME) and System-Managed Encryption (SME), using T10 encryption methods, for SAS and Fibre Channel drives only. Data encryption is supported with LTO Ultrium 4 Data Cartridges only. Encryption is also supported for library firmware version 4.0 and higher and drive firmware level 74H4 or higher.

The encryption-enabled drive contains the necessary hardware and firmware to encrypt and decrypt host tape application data. Encryption policy and encryption keys are provided by the host application or host server. A drive digital certificate is installed at manufacturing time. Each drive receives a unique serial number and certificate. The T10 application might validate each drive instance by checking the drive's digital certificate. AME is supported on AIX, Windows 2000 Server, Linux, and Solaris. Encryption requires the latest device drivers that are available on the ftp download site:


The LTO Ultrium 4 encryption environment can be complex and requires knowledge beyond that of a product-trained IBM service support representative (SSR). In the Tape Storage environment, the Encryption function on tape drives (desktop, stand-alone, and within libraries) is configured and managed by the client. In certain instances, SSRs will be required to enable encryption at a hardware level when service access or service password controlled access is required.

Tape Encryption is available at no charge for AME. Feature Code (FC) 1604 (for the TS3500 Tape Library) or FC5900 (for all other tape libraries) and FC9900 must be ordered when you are planning to work with SME.
8.6 LTO data cartridges

When processing the Ultrium Tape Cartridge, the Ultrium Tape Drive uses a linear, serpentine recording format. The Ultrium 3 drive reads and writes data on 704 tracks, sixteen tracks at a time, and the Ultrium 4 drive writes data on 896 tracks. For additional details refer to “Tape cartridge” on page 42.

To ensure that your IBM Ultrium Tape Drive conforms to the IBM specifications for reliability, use only IBM LTO Ultrium tape cartridges. The IBM TotalStorage LTO Ultrium 400 GB and 800 GB Data Cartridge cannot be interchanged with the media used in other IBM non-LTO Ultrium tape products.

The native data capacity of Ultrium data cartridges is listed in Table 8-2.

Table 8-2 Native capacity

<table>
<thead>
<tr>
<th>Data cartridge</th>
<th>Native data capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultrium 4 WORM</td>
<td>800 GB (1600 GB at 2:1 compression)</td>
</tr>
<tr>
<td>Ultrium 3 WORM</td>
<td>400 GB (800 GB at 2:1 compression)</td>
</tr>
<tr>
<td>Ultrium 4</td>
<td>800 GB (1600 GB at 2:1 compression)</td>
</tr>
<tr>
<td>Ultrium 3</td>
<td>400 GB (800 GB at 2:1 compression)</td>
</tr>
<tr>
<td>Ultrium 2</td>
<td>200 GB (400 GB at 2:1 compression)</td>
</tr>
<tr>
<td>Ultrium 1</td>
<td>100 GB (200 GB at 2:1 compression)</td>
</tr>
</tbody>
</table>

8.6.1 Cartridge compatibility

Table 8-3 shows the compatibility among the four types of Ultrium cartridges.

Table 8-3 Ultrium data cartridge compatibility

<table>
<thead>
<tr>
<th>IBM Ultrium Tape Drive</th>
<th>IBM TotalStorage LTO Ultrium Data Cartridge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>800 GB (Ultrium 4)</td>
</tr>
<tr>
<td>Ultrium 4</td>
<td>Read/Write</td>
</tr>
<tr>
<td>Ultrium 3</td>
<td>N/A</td>
</tr>
<tr>
<td>Ultrium 2</td>
<td>N/A</td>
</tr>
<tr>
<td>Ultrium 1</td>
<td>N/A</td>
</tr>
</tbody>
</table>

8.6.2 Write Once Read Many (WORM)

Certain records retention and data security applications require a Write Once Read Many (WORM) method for storing data on tape. To meet this data storage requirement, a new
WORM feature is available on IBM LTO Ultrium generation 3 drives. You can enable the WORM feature by upgrading to WORM-capable drive firmware and using a special WORM tape cartridge.

The IBM Ultrium LTO4 Tape Drive uses the LTO4 WORM cartridges and gives full support for the use of WORM data cartridges.

**WORM Media**

A specially formatted WORM tape cartridge is required, because standard Read/Write media are incompatible with the WORM feature. Each WORM cartridge has a unique, worldwide cartridge identifier (WWCID), which comprises the unique Cartridge Memory (CM) chip serial number and the unique tape media serial number.

**Data security on WORM media**

Certain built-in security measures help ensure that the data written on a WORM cartridge does not become compromised, for example:

- The format of an IBM Ultrium 3 and Ultrium 4 400 GB and 800 GB WORM Tape Cartridge is unlike that of standard Read/Write media. This unique format prevents a drive that lacks WORM-capable firmware from writing on a WORM tape cartridge.
- When the drive senses a WORM cartridge, the firmware prohibits changing or altering user data already written on the tape. The firmware keeps track of the last appendable point on the tape.

### 8.6.3 Cleaning cartridge

A specially labeled IBM LTO Universal Ultrium Cleaning Cartridge will clean the drive in your library. One cleaning cartridge ships with the IBM TS3100 Tape Library.

The drive itself determines when a head needs cleaning and communicates this to the library. When the cleaning is finished, the drive ejects the cartridge and the picker takes the cartridge and places it back in any storage slot. To remove a cleaning cartridge, export it from the library.

The IBM Cleaning Cartridges are valid for 50 uses. The cartridge's LTO-CM chip tracks the number of times that the cartridge is used.

### 8.6.4 Cartridge Memory chip (LTO-CM)

All generations of the IBM LTO Ultrium Data Cartridges include a Linear Tape-Open Cartridge Memory (LTO-CM) chip that contains information about the cartridge and the tape (such as the name of the manufacturer that created the tape), as well as statistical information about the cartridge's use.

The LTO-CM enhances the efficiency of the cartridge. For example, the LTO-CM stores the end-of-data location that the next time this cartridge is inserted and the Write command is issued enables the drive to quickly locate the next available recording area and begin recording.

The LTO-CM also helps determine the reliability of the cartridge by storing data about its age, how many times it has been loaded, and how many errors it has accumulated. Whenever a tape cartridge is unloaded, the tape drive writes any pertinent information to the cartridge memory. The storage capacity of the LTO-CM is 4096 bytes for Ultrium 3 and 8192 bytes for Ultrium 4. Refer to “Cartridge memory (LTO-CM)” on page 45 for more details.
8.7 IBM TS3100 Tape Library setup

The following section provides an introduction to the necessary steps to implement, manage, and operate the IBM TS3100 Tape Library. For a more detailed description, refer to the *IBM System Storage TS3100 Tape Library and TS3200 Tape Library: Setup, Operator, and Service Guide*, GA35-0545.

After unpacking and installing the IBM TS3100 Tape Library, you must perform a few steps to connect it to a host.

8.7.1 User interfaces

There are two ways to configure the library: using the Operator Control Panel (OCP) and the Web User Interface. You use the OCP and the Web User Interface to complete the installation of the IBM TS3100 Tape Library. The OCP is located on the front panel of the library and the Web User Interface is accessed via the Web browser.

**The Operator Control Panel interface**

The Operator Control Panel operates in one of two modes:

- **User Interaction mode:** This mode is employed when you press buttons on the Operator Control Panel.
- **System Driven mode:** This is the normal mode of operation. In this mode, the OCP displays the status associated with the actions that were caused by commands issued via the drive’s internal (drive to library) serial interface.

When you press and release an OCP button, the OCP automatically transitions to User Interaction mode. User Interaction mode will continue until three minutes after you stop pressing buttons or until the requested accessor action stops, whichever is longer. At this time, the OCP returns to System Driven mode.

If necessary, the Operator Control Panel automatically transitions to the System Driven mode. When this occurs, the library must remember what you were doing before the display mode changed. Therefore, the next button pressed only transitions the OCP to the User Interaction mode from the System Driven mode. In the case of the activated user security feature, the User Interaction mode is restricted to Login and Monitor menu items, until a user logs in with a correct password.

**Web User Interface**

You can perform many of the same operations performed from the Operator Control Panel remotely using the Web User Interface. The Web User Interface lets you monitor and control your library from any terminal connected to your network or through the World Wide Web.

The Web User Interface hosts a dedicated, protected Internet site that displays a graphical representation of your library. After establishing a connection to the library, open any HTML browser and enter the IP address of the library. To configure the Web User Interface, you must set the IP address. Library supports IPv4, IPv6 or Dual Stack IPv4 + IPv6 transportation.

For IPv4 or Dual Stack IPv4 + IPv6, enter your library’s static IP Address using the 0.0.0.0 format (four octets).

For IPv6, enter your library static IP Address or Router Assigned IP Address using the following format: http://[0:0:0:0:0:0:0:0]. To determine your Router Assigned IP Address, navigate to **Monitor → Library → Network** on the Operator Control Panel. For the IPv6
Router Assigned Addresses to be displayed on the Operator Control Panel, the Network must be configured to IPv6 only and the Stateless Autoconfig must be set to **ON**.

Figure 8-12 show you the Network Configuration panel view from the Web User Interface.

![TS3100 Network Configuration Panel](image)

**Figure 8-12  TS3100 Network Configuration panel**

### 8.7.2 Configuring the IBM TS3100 Tape Library

One of the benefits of the IBM TS3100 Tape Library is the standard Remote Management Unit (RMU). You can configure and monitor the IBM TS3100 Tape Library remotely, as well as update the firmware of the library and the drive remotely. RMU uses an Ethernet connection to access the IBM TS3100 Tape Library. For the initial setup, you can use the default configuration, which is:

- **Dynamic Host Configuration Protocol (DHCP): On**
- **Network Address: 0.0.0.0**
- **Drive ID:**
  - 4 for a SCSI Drive
  - 4 for a Fibre Channel Drive
- **Library mode: Random**

Making a direct connection to the IBM TS3100 Tape Library might require a crossover Ethernet cable.

Figure 8-13 shows the Library Mode menu and the configuration options.
Figure 8-13   Configure: Library Settings

From the Mode menu, you select the Library Mode. Two library modes are available for the IBM TS3100 Tape Library:

1. In Random mode, the library allows the server's (host's) application software to select any data cartridge in any order.

2. In Sequential mode, the library’s firmware predefines the selection of the cartridges. After initialization, the firmware causes the library to select the first available cartridge found (counting from 1 through 22) for loading into the drive. In Figure 8-13, you find the tree structure of the Library mode menu.

   In combination with Sequential mode, you can turn on two additional modes:

   - **Autoload**
     Sequential mode with autoload mode ON loads the first cartridge automatically if the library powers ON with an empty drive.

   - **Loop**
     Sequential mode with loop mode ON loads the cartridge in slot 1 after the cartridge in slot 22 has been filled and sent back to its home slot. This allows endless backup operations without user interaction.

You also define the number of Active Slots you want to assign in your library. Slots can be reserved so that they are invisible to the host. It might be necessary to set the number of active slots in order to match the number of available slots to the Independent Software Vendor (ISV) software licensing.

**Note:** When the IBM TS3100 Tape Library is connected to a System i, you must IPL the input/output adapter (IOA); otherwise, System i will not recognize the new mode.

You can connect the library to the host after setting up the library mode. Here are several considerations before you connect the library to the host. Two host connections are available: SCSI and the Fibre Channel connection.
8.7.3  SCSI Host Bus Adapter (HBA) support

For SCSI hosts, verify that the HBA of your server is supported. Check the IBM Interoperability Matrix, which you can find at:

http://www-03.ibm.com/servers/storage/tape/resource-library.html#interoperability

Select TS3100 Tape Library as shown in Figure 8-14.

The library uses a single SCSI or Loop ID per drive and dual logical unit numbers (LUNs) to control the tape drive (LUN 0) and library accessor (LUN 1). The library requires a host bus adapter (HBA) that supports LUN scanning. If it is not enabled, your host system will not scan beyond LUN 0 and will fail to discover the library. It will only see the tape drive.

Note: Some HBAs, such as RAID controllers, do not support LUN scanning.

If you daisy-chain the IBM TS3100 Tape Library, the last device on the bus must have a SCSI terminator installed. The IBM Ultrium 3 LVD tape device supports a bus length of 25 m (82 ft.) point-to-point and 12 m (39 ft.) using a multi-drop interconnection. For each daisy-chained device, you must reduce the maximum cable length by 0.5 m (1.6 ft.).

8.7.4  Fibre Channel (FC)

Make sure that the FC HBA of your server is supported. Check the IBM HBA Support Web site at:

http://www-03.ibm.com/servers/storage/support/config/hba/index.wss

Select TS3100 (3573) with Ultrium 3 FCP drives, as shown in Figure 8-15 on page 205.
Another way to find out if your Fibre Channel Tape Drive is supported is to visit this Web site:


Figure 8-16 on page 206 shows the link to the IBM Technical Support Web site. Click **System Storage Interoperation Center** and follow the instructions.
8.7.5 Serial Attached SCSI (SAS)

At the time of writing this book, there was no information available on the Web. Two HBAs however are supported:

- LSI Logic SAS3800X
- IBM SAS HBA Controller model 25R8060

8.7.6 Firmware

At installation time, verify that the most current firmware is installed for both the library and the tape drive. The IBM TS3100 Tape Library is designed as a Customer Setup Machine (CSU), and it is the customer's responsibility to have the current firmware. Determine the current level of firmware available from IBM Technical Support Web sites:

http://www.ibm.com/storage/lto

ftp://index.storsys.ibm.com

The preferred way to update the drive firmware is to use the Web User Interface to update the library and the drive firmware. The RMU or Web User Interface comes standard with the IBM TS3100 Tape Library. This provides a much simpler method for System i clients to update firmware than was previously available. The Field Microcode Replacement (FMR) function is not supported on the IBM TS3100 Tape Library.

The IBM TotalStorage Diagnostic Tool (ITDT) is an alternate way to update the drive firmware, take a dump of a drive, and to test the drive and library. This tool is supported on the following servers:
The latest version of the ITDT is V2.0 and it comes in two flavors:

**ITDT SE**
This is a version like the previous ITDT version and is mainly a command line driven tool.

**ITDT GE**
This is called ITDT Graphics Edition, and is a Graphical User Interface version that you use if the Operating Systems running on the servers are Window XP or 2003. Please install Java before using ITDT-GE. You can download a Java version from:

http://www.ibm.com/java
http://www.java.com

You can download the ITDT tool from this IBM Web site:

http://www-03.ibm.com/servers/storage/support/

To locate the tool, search on *ITDT V2.0*.

The ITDT supports both SCSI and Fibre Channel drives. The ITDT does not use any installed device driver and is therefore also an excellent tool to use to test the drives. After the IBM TS3100 is connected to the host and the ITDT is started from a command prompt, the tool scans the bus, and it finds and displays all IBM LTO devices. You can also use tapeutil via the SCSI interface.

Using the ITDT, you can force dumps on a drive and have the output sent to an IBM Support Center for further analysis.

### 8.7.7 Cartridge magazines

The IBM TS3100 Tape Library has two removable magazines in the library. Magazine access can be password-protected. For safety reasons, the accessor motion stops when a magazine is removed.

You can release the magazines using the Operator Control Panel or the Web User Interface. In case the Operator Control Panel or Web User Interface-initiated process fails or the library no longer has power, a manual emergency release is available.

The I/O station is part of the left magazine. To open the I/O station, grasp the lower handle of the left magazine and gently pull the I/O station open. To close the I/O station, gently push it back into the left magazine.

**Inserting cartridges into the IBM TS3100 Tape Library**

The last task is now to insert cartridges into the IBM TS3100 Tape Library:

1. Unlock the cartridge magazines using the OCP or the Web User Interface.
2. Remove both magazines from the library.
3. Insert cartridges in the magazine. Do not store in the I/O station.
4. Insert cartridges in any slot of the right magazine.
5. Put both magazines back into the library.

8.8 Physical specifications

The TS3100 Tape Library is a medium-sized tape library with the following dimensions:

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width</td>
<td>44.74 cm (17.6 in.)</td>
</tr>
<tr>
<td>Depth</td>
<td>74 cm (29.1 in.)</td>
</tr>
<tr>
<td>High</td>
<td>8.76 cm (3.4 in.)</td>
</tr>
<tr>
<td>Weight</td>
<td>With one drive and without media 15.59 kg (34.37 lbs.)</td>
</tr>
</tbody>
</table>

8.9 Feature codes

The IBM TS3100 Tape Library can be ordered with the optional features listed in Table 8-4.

<table>
<thead>
<tr>
<th>Feature code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5096</td>
<td>LC-SC Fibre Channel Cable Interposer</td>
</tr>
<tr>
<td>5602</td>
<td>2.5 m VHDCI/HD68 SCSI Cable</td>
</tr>
<tr>
<td>5604</td>
<td>4.5 m VHDCI/HD68 SCSI Cable</td>
</tr>
<tr>
<td>5610</td>
<td>10 m VHDCI/HD68 SCSI Cable</td>
</tr>
<tr>
<td>5900</td>
<td>Transparent LTO Encryption. This feature provides license keys to enable SME and LME</td>
</tr>
<tr>
<td>6005</td>
<td>5 m LC/LC Fibre Cable</td>
</tr>
<tr>
<td>6013</td>
<td>13 m LC/LC Fibre Cable</td>
</tr>
<tr>
<td>6025</td>
<td>25 m LC/LC Fibre Cable</td>
</tr>
<tr>
<td>7002</td>
<td>Rack Mount Kit with Power Cord</td>
</tr>
<tr>
<td>8002</td>
<td>Universal Cleaning Cartridge</td>
</tr>
<tr>
<td>8043</td>
<td>Ultrium 3 LVD SCSI Tape Drive</td>
</tr>
<tr>
<td>8044</td>
<td>Ultrium 3 4 Gb/s Fibre Channel Tape Drive</td>
</tr>
<tr>
<td>8046</td>
<td>Ultrium 3 Half-High LVD SCSI Tape Drive</td>
</tr>
<tr>
<td>8047</td>
<td>Ultrium 3 Half-High SAS Tape Drive</td>
</tr>
<tr>
<td>8106</td>
<td>Right Side Magazine Set</td>
</tr>
<tr>
<td>8143</td>
<td>Ultrium 4 Full-High LVD SCSI Tape Drive</td>
</tr>
<tr>
<td>8144</td>
<td>Ultrium 4 Full-High Fibre Channel Tape Drive</td>
</tr>
<tr>
<td>8145</td>
<td>Ultrium 4 Full-High SAS Tape Drive</td>
</tr>
<tr>
<td>8305</td>
<td>Data Cartridges (GEN3) 5-pack</td>
</tr>
<tr>
<td>8405</td>
<td>Data Cartridges (GEN4) 5-pack</td>
</tr>
<tr>
<td>9848</td>
<td>Additional Rack to PDU Line Cord</td>
</tr>
</tbody>
</table>
Table 8-5 lists the feature codes available for SAS attachment.

<table>
<thead>
<tr>
<th>Feature code/HVEC</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>9900</td>
<td>Encryption Configuration. This feature should be ordered when encryption will be used in the library. It includes publication updates with information about enabling and configuring the library to support encryption. This feature also provides an Encryption Key Manager (EKM) publication.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feature code/HVEC</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5402</td>
<td>2 m SAS/Mini-SAS 1x cable</td>
</tr>
<tr>
<td>5406</td>
<td>5.5 m SAS/Mini-SAS 1x cable</td>
</tr>
<tr>
<td>5500</td>
<td>Mini-SAS/550x 4x Interposer</td>
</tr>
<tr>
<td>5502</td>
<td>2 m Mini-SAS/Mini-SAS 1x cable</td>
</tr>
<tr>
<td>5506</td>
<td>5.5 m Mini-SAS/Mini-SAS 1x cable</td>
</tr>
<tr>
<td>8405</td>
<td>Ultrium 4 Data Cartridges (5-pack)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Feature code/HVEC</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5402</td>
<td>This feature provides a SAS cable with a SAS (SFF-8470) connector on one end and a Mini-SAS (SFF-8088) connector on the other end.</td>
</tr>
<tr>
<td>5406</td>
<td>This feature provides a SAS cable with a SAS (SFF-8470) connector on one end and a Mini-SAS (SFF-8088) connector on the other end.</td>
</tr>
<tr>
<td>5500</td>
<td>This feature provides a 1x4 interposer with mini-SAS/550x connections for connecting the library and drives.</td>
</tr>
<tr>
<td>5502</td>
<td>This feature provides a SAS cable with a Mini-SAS (SFF-8088) connector on one end and a Mini-SAS (SFF-8088) connector on the other end.</td>
</tr>
<tr>
<td>5506</td>
<td>This feature provides a SAS cable with a Mini-SAS (SFF-8088) connector on one end and a Mini-SAS (SFF-8088) connector on the other end.</td>
</tr>
<tr>
<td>8405</td>
<td>This feature provides five unlabeled 800 GB data cartridges only with ordering the TS2340.</td>
</tr>
</tbody>
</table>