hardware integration

hp ultrium tape drives technical reference manual

generation 2 SCSI drives

volume 1: hardware integration guide

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This document is frequently revised and updated. To find out if there is a later version, please ask your HP OEM Representative.

The Purpose of this Manual

This is one of five volumes that document HP Ultrium drives. The Hardware Integration Guide provides information for engineers tasked with integrating HP Ultrium internal drive tape products into third-party servers or libraries.

For further general information, including detailed descriptions of the major component parts of the drive mechanism, see Chapter 3, "Hardware" in **Background to Ultrium Drives**, Volume 6 of the Ultrium Technical Reference Manual.

The following pages give details of installing, using and troubleshooting drives in libraries, in tape arrays, installed in servers and as standalone external drives.

Related Documents

The following documents provide additional information:

Documents Specific to HP Ultrium Drives

- **Software Integration Guide**, volume 2 of the HP Ultrium Technical Reference Manual
- **The SCSI Interface**, volume 3 of the HP Ultrium Technical Reference Manual
- **Specifications**, volume 4 of the HP Ultrium Technical Reference Manual
- **HP Ultrium Configuration Guide**, volume 5 of the HP Ultrium Technical Reference Manual
- **Background to Ultrium Drives**, volume 6 of the HP Ultrium Technical Reference Manual
- **HP Ultrium Technology** White Paper, which describes the features and benefits of HP Ultrium drives

Please contact your HP supplier for copies.

Documentation Map

The following will help you locate information in the 6-volume Technical Reference Manual:

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General Documents and Standardization

- For a general backgrounder on LTO technology and licensing, go to `http://www.lto-technology.com`.
- Small Computer System Interface (SCSI-1), ANSI X3.131-1986. This is the ANSI authorized standard for SCSI implementation, available through ANSI
- Enhanced Small Computer System Interface (SCSI-2), ANSI X3T9.2-1993 Rev. 10L, available through ANSI
- Information Technology — SCSI Parallel Interface-3 (SPI-3), T10 Project 1302D, Working Draft Revision 14

Copies of General Documents can be obtained from:

ANSI 11 West 42nd Street
New York, NY 10036-8002
USA

ISO	CP 56 CH-1211 Geneva 20 Switzerland	
ECMA	114 Rue du Rhône CH-1204 Geneva Switzerland	*Tel:* +41 22 849 6000 *Web URL:* `http://www.ecma.ch`
Global Engineering Documents	2805 McGaw Irvine, CA 92714 USA	*Tel:* 800 854 7179 or 714 261 1455

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Ultrium Drives in Libraries

1

Introduction

This chapter contains information that relates to placing an HP Ultrium drive in an automated device, such as an autochanger or a tape library:

- Drives for use in libraries have different front panels from drives mounted individually in servers and standalone drives. There is also a special front panel for use in autoloaders. These are described on page 18.
- For notes on the requirements and other details for the installation of drives into libraries, see page 21.
- For notes on the operation of drives in libraries, see page 23.
- For troubleshooting information, see page 25.

Chapter 2 contains information about using special features of Ultrium drives in libraries:

- The "Automation Control Interface (ACI)" allows the activities of the drive to be coordinated within a library. See page 27 for details.
- "Configuring Autoload and ACI-Controlled Loads" on page 44 allows you to configure whether automatic or ACI-controlled loads and unloads occur.
- LTO Contactless Memory (LTO-CM) or Cartridge Memory is EEPROM memory that is embedded in every LTO Ultrium tape cartridge. It is non-volatile and is contactless in that it is read by RF coupling rather than electrical contact.
  - For suggestions of how to make use of cartridge memory in libraries, see "Using Cartridge Memory (LTO-CM)" on page 47.
  - For general information about LTO-CM, see "LTO Cartridge Memory" in Chapter 5, "Cartridges" in **Background to Ultrium Drives**, Volume 6 of the Ultrium Technical Reference Manual.

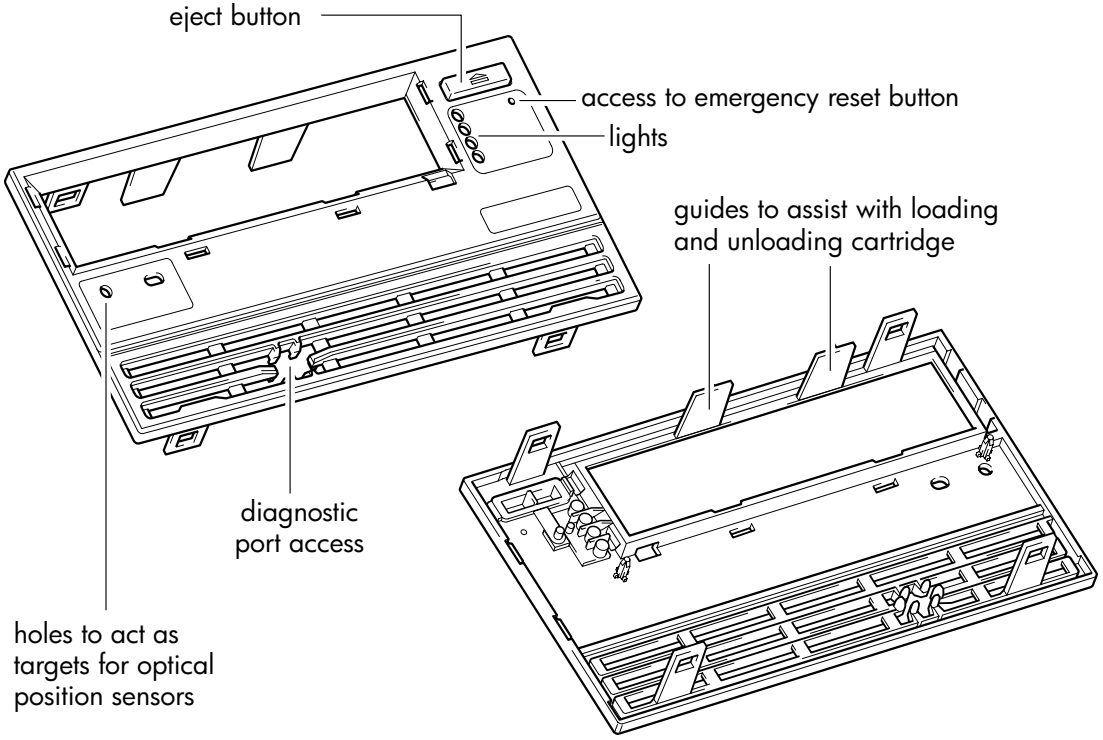
Backup Software

You need backup application software that supports your Ultrium drive and tape library.

Suitable backup applications will include driver software that establishes the interface between the tape drive and the software. Applications usually recognize tape drives by their manufacturers' ID string rather than their model number, so check the following table for the appropriate reference.

Drive Model ID String
SCSI drive "`HP Ultrium 2-SCSI`"

Front Panel for Automation Use

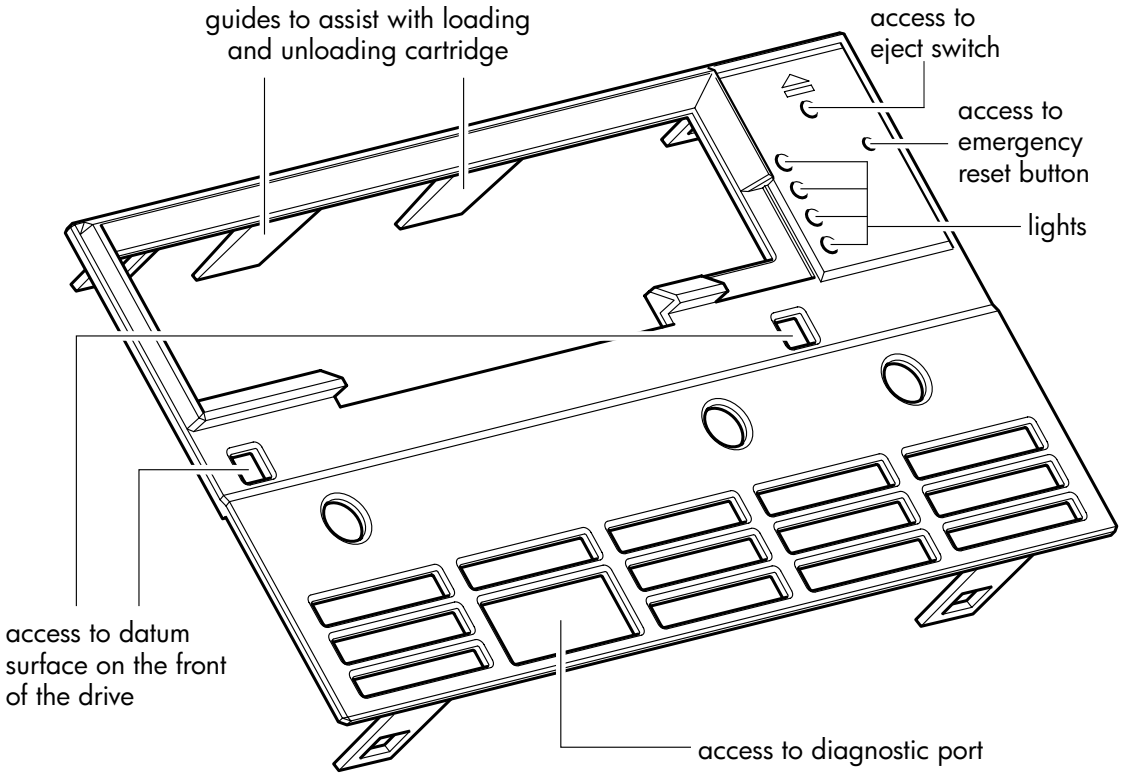


The automation front panel has the following features:

- There is an eject button for manually ejecting a cartridge. Press this for approximately five seconds to start a “forced eject” for recovering a cartridge manually.
- Indicator LEDs provide a visible indicator of the state of health of the drive. See Chapter 6 on page 93 for details.
- There is no door. Instead there are two fixed guides to guide the cartridge into the drive.
- There is access to an RS-422 serial diagnostics port. Diagnostic information from the drive such as power-on hours, tape-pulling hours, error codes, and firmware trace-logs can be accessed by connecting to the serial communications port on a computer. Please contact HP for further details on this diagnostics port.
- The indent for a label on the left just under the cartridge opening is left blank, exposing two holes. These can be used to provide a target for the optical position sensor of a library picker.
- There are additional holes around the cartridge opening to allow a throat to be fitted if necessary, to help the smooth loading of cartridges.

Front Panel for Use in Autoloaders

A special front panel is available for autoloader applications where the autoloader conforms to a 2U product height. The front panel fits within the drive form factor in height and width:



The autoloader front panel has the following features:

- Simple one-piece plastic design
- Pin hole access to the eject switch on the drive for manually ejecting a cartridge. Press this for approximately five seconds to start a "forced eject" for recovering a cartridge manually.
- Indicator LEDs provide a visible indicator of the state of health of the drive. See Chapter 6 on page 93 for details. The LEDs are viewed through holes in the autoloader front panel; no light pipes are present.
- Access to an RS-422 serial diagnostics port. Diagnostic information from the drive such as power-on hours, tape-pulling hours, error codes, and firmware trace-logs can be accessed by connecting to the serial communications port on a computer. Please contact HP for further details.
- Clearance for picker finger access to the right-side cartridge-handling notch

- Two square holes through the panel to provide access to a datum surface on the front of the drive
- Cartridge lead-in features to improve cartridge load and unload operations

Installing Drives

Airflow requirements

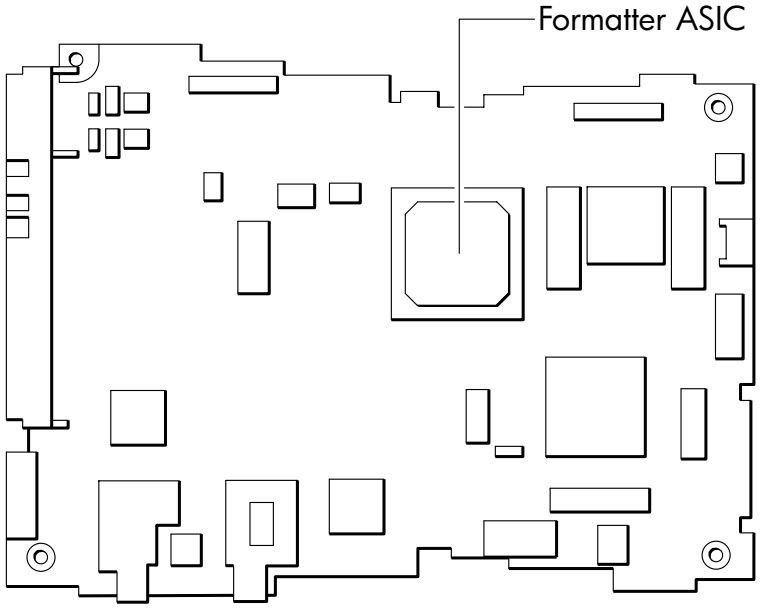
HP Ultrium drives require forced airflow from front to back or from back to front. The required flow depends on the ambient air temperature:

- 8 cfm for ambient air temperatures fluctuating in the range 10°C–40°C.
- 6 cfm for ambient air temperatures fluctuating in the range 10°C–35°C.

Measuring Internal Drive Temperatures

The most accessible place to measure internal temperatures to ensure that airflow is adequate is the case lid of the Formatter ASIC (U6):

heat-sinks removed



A thermocouple placed on the ASIC should not exceed 25°C over the ambient air temperature while the drive is stream writing for at least one full hour. Thus for an ambient temperature of 25°C, the U6 case lid should remain under 50°C.

Electrical Fit

The drive is specified to operate at 5V±5% and 12V±10%.

Voltage and current requirement are as follows:

Specification	5V	12V
Maximum voltage	5.25V	13.2V
Minimum voltage	4.75V	10.8V
Maximum steady-state current	3.5A	1.0A
Maximum transient current	3.5A	2.5A
Maximum steady-state power	17.5W	12W
Maximum transient power	17.5W	30W
Maximum noise/ripple	150 mVpp	150 mVpp

Rear Panel and Connectors

Caution Ultrium tape drives are not installable or replaceable by end-users, so the attachment or removable of SCSI, power and ACI cables between the tape drive and the tape library should only be carried out be service-trained personnel authorized by the tape library supplier. The connectors are not field upgradeable.

The rear panel contains the connector interface that allows the tape drive to communicate with the tape library and host computer system. The panel includes the following connectors:

- A three-part SCSI connector.

  This incorporates a 68-pin high density SCSI connector, a 4-pin power connector and a 12-pin auxiliary connector used with jumpers to set the SCSI ID. The SCSI and power connectors interface with appropriate cables connected to the library bulkhead. The SCSI cables may be installed in a daisy-chain configuration linking two or more Ultrium tape drives within the library together on the same SCSI bus.

Tape library suppliers set the SCSI jumpers to 3 before a tape drive is installed. This will be overridden by the tape library. Each device on the SCSI bus must have a unique SCSI ID set by the library.

For details of the SCSI connector, see page 101.

- ACI (for automation use). For details of the connector, see page 101. For details of the use of the ACI in libraries, see page 49.

Operating Drives

Drives installed in a tape library are controlled through the tape library operator panel. Refer to the tape library documentation for details.

Cleaning

When the drive needs cleaning, the orange 'Clean' LED on the tape drive will flash. Only insert a cleaning cartridge into the tape drive when the LED flashes.

The tape drive also tells the automation controller that a cleaning tape needs to be used through two bits in the ACI Get Drive Status command.

- The Cleaning Needed bit signals deterioration in the write or read margin of the drive and indicates that a cleaning cartridge should be used as soon as possible. Once the drive has been cleaned successfully, the Cleaning Needed bit will be cleared.
- The Cleaning Required bit indicates that the drive is unable to read or write unless the drive is first cleaned, so a cleaning cartridge should be used immediately. Following a successful clean, the Cleaning Required bit will be cleared.

See the **ACI Specification** for details of ACI commands.

Caution Only use Ultrium cleaning cartridges with HP Ultrium tape drives. Do not use swabs or other means of cleaning the heads.

A cleaning cartridge can be used up to 50 times.

To clean the heads:

1. Insert a cleaning cartridge into the drive. The tape drive automatically loads the cartridge and cleans the heads.

If the cleaning cartridge ejects immediately, it has expired or it is not an Ultrium cleaning cartridge (or is an older Ultrium Generation 1 cleaning cartridge manufactured by a vendor other than HP). In this case, discard the cleaning cartridge and repeat the operation with a new one.

The cleaning cycle can take up to 3 minutes. During it the orange 'Clean' LED will be on and the green 'Ready' LED will flash. When it has finished, the drive ejects the cartridge.

2 Remove the cleaning cartridge from the drive.

Resetting Drives

The tape drive can be reset by the automation controller via the ACI Reset command or by pulling the ACI_RST_L line low (see page 101).

There are two levels of reset via the ACI interface:

- ACI reset—resets the ACI port and all SCSI parallel ports
- Drive reset—equivalent to a power-on reset

Either reset method will interrupt the interface between the drive and host. An ACI reset may result in no End of Data mark being written. As a result, it is strongly recommended that an ACI reset command is not sent unless all other recovery methods have failed. Note that certain ACI commands (Load, Unload, Set Drive Configuration, Reset and Set Baud Rate) can be queued behind outstanding SCSI commands giving the impression that the drive has stopped responding over the ACI bus. (All command packages will be still be ack'ed even though the command will be queued.)

Following an ACI Reset command with reset control set to Drive Reset or after pulling the ACI_RST_L line low, the drive will behave as if it has powered up and will go off bus and lose all ACI configurations.

A SCSI interface reset will not affect the ACI interface.

Note that following an upgrade of the drive firmware either via tape or SCSI the drive will be reset as if it had been powered up.

Troubleshooting

If you experience problems when using your tape drive within an automation environment, you need to isolate the cause of the problem. For example, if you have just installed a new SCSI host bus adapter in your host system and your system will not start, the cause of the problem is likely to be the adapter.

The first step in problem-solving is establishing whether the problem lies with the cartridge, the drive, the tape library, the host computer and its connections, the operating system or backup application on the host, or operator error.

Please refer to troubleshooting information provided with the tape library, the host or the backup software if the problem seems to lie in one of these areas.

If none of the following advice helps you solve the problem, contact your tape library supplier.

Diagnostics

HP Ultrium tape drives continuously monitor and gather information that can be used for diagnostics purposes. Data such as tape-pulling hours, power-on hours, usage information on cartridges, firmware trace-logs, and error logs can be extracted from the drive to aid ongoing health checks or to aid the diagnosis in cases of failure. The data can be extracted using three methods, namely via SCSI LOG SENSE commands, ACI Log Sense commands, or via the serial diagnostics port using a proprietary serial interface application.

Please contact HP for further details of the diagnostics capability of the drive and to receive a copy of the Diagnostics Guide detailing how to extract and interpret the information.

Interpreting the LEDs on Individual Drives

HP Ultrium tape drives have four LEDs on the front. See Chapter 6 on page 93 for details of what various patterns of these LEDs mean.

Cleaning Issues

Use the following table to resolve cleaning problems:

Problem	Solution
Recurring cleaning message.	Clean the drive as instructed in the tape library documentation. If the message reappears, replace the cleaning cartridge with a new one. If the message reappears when a particular data cartridge is used, verify that the data cartridge is readable by clearing the message and reading the tape again. If the data cartridge can be read, back up the data to another cartridge and then discard the damaged one.
A brand new data cartridge is used, and the library operator panel indicates that cleaning is required.	Clean the outside of the data cartridge with a barely damp, clean, lint-free cloth. Clean the drive as instructed by your tape library documentation. If the operator panel indicates cleaning is required within a short period of time, replace the data cartridge.
The cleaning cartridge is ejected immediately after loading.	Make sure that you are using an approved Ultrium cleaning cartridge.

Using Special Features in Libraries

2

Introduction

This chapter contains information that relates to placing an HP Ultrium drive in an automated device, such as an autochanger or a tape library.

- The "Automation Control Interface (ACI)" described below allows the activities of the drive to be coordinated within a library.
- "Configuring Autoload and ACI-Controlled Loads" on page 44 tells you how to configure whether automatic or ACI controlled loads and unloads occur.
- "Using Cartridge Memory (LTO-CM)" on page 47 describes the EEPROM embedded in every Ultrium tape cartridge, part of which is available for use by applications.

Drives for inclusion in automated devices have different front panels from individual drives.

Automation Control Interface (ACI)

The Automation Control Interface (ACI) allows the activities of the drive to be coordinated within a library. The protocol has been designed so that it can be made into a standard feature of tape drives. It provides a rich and extensible functionality to allow automation manufactures to add value in their application of it.

The interface is a serial bus with additional control lines, designed to connect the Ultrium tape drive to an automation controller in a tape library. Each tape drive position has a separate automation controller. An RS-422 serial port on the rear of the drive allows for ACI connection—see page 101 for details.

The ACI provides the following fundamental functions:

- Coordinating the automation controller and the tape drive for Load and Unload operations
- Allowing the automation controller to retrieve information from the tape drive
- Setting tape drive configuration information

In addition, the following functions may be supported depending on the way that the tape library is configured:

- Providing upload and download of firmware images
- Providing access to the contents of the Cartridge Memory
- Providing a protocol for passing SCSI commands to the tape drive over the interface

Note These notes refer to the "standard" automation drive variant.

Modes of Usage

There are three ways in which the drive can be used through ACI control:

Slave to a Library Controller

The ACI can receive commands such as Load and Unload from a specially defined automation command set to control the action of the drive.

Most tape libraries need to be able to do this because they need to have close control over any mechanical operations of the drive that could interfere with the operation of the picker arm. For instance, in a soft load device such as an Ultrium drive, the picker must let go of the cartridge at the exact moment that the drive starts to pull it into the drive.

This degree of control over synchronization cannot be achieved though the host's backup software; it must be controlled directly by the library controller. Most tape libraries work this way today. The process is transparent to the backup software.

SCSI Pass-Through Mode

The ACI can receive "packetized" SCSI commands from an attached controller and submit them to the tape drive as if they have been received on the drive's own SCSI bus. This enables the attached controller to access and control the drive in exactly the same way as it would via the SCSI bus.

Surrogate SCSI

Surrogate SCSI allows the SCSI commands to the library from the host to be routed via the SCSI interface of the drive, thus saving on the cost of a separate SCSI interface for the library controller. Typically, the drive will be assigned LUN 0 and the library controller will be assigned LUN 1 at the same SCSI address.

The drive acts as a conduit for the commands from the host to the library controller and passes the commands directly to the library controller via the ACI link. The status or data in turn is passed from the library controller to the host via the ACI link and the tape drive SCSI interface.

This functionality will be implemented based on customer need. The implementation details are beyond the scope of this document currently.

Supporting the ACI

Software vendors implementing support for attached library devices will need to work closely with the library vendor concerned. HP will be producing an "Ultrium Automation Cookbook" to explain the operation of the SCSI Surrogate facility, but the content and usage of such surrogate commands will be ultimately determined by the library vendor.

ACI Command Set

The following ACI commands are supported on HP Ultrium drives:

Mandatory Commands	
00h	Get Drive Info
01h	Load
02h	Unload
03h	Get Drive Status
04h	Set Drive Configuration
05h	Get Drive Configuration
06h	Reset
07h	Set Baud Rate
08h	No Op

Optional Commands	
40h	Send SCSI Command
42h	Send Firmware Image
43h	Get Firmware Segment
44h	Get SCSI CDB
45h	Send SCSI Data
46h	Get SCSI Data
47h	Send SCSI Status
48h	Configure SCSI Surrogate
49h	Get Buffer Size

Mandatory Commands	
09h	Get Error Info
0Ah	Acknowledge Attention

Optional Commands	
4Ah	Send Firmware Segment
4Bh	Set Time
4Ch	Get Time

For full details of how these commands are used, see the Automation Controller Specification, available from HP.

Recommended ACI Time-out Values

ACI commands fall into three broad classes:

- Commands that the drive executes immediately
- Commands that the drive queues but which it can execute concurrently with auto-mode reads and writes (in other words, streaming operation)
- Commands that the drive queues but which interrupt streaming operation.

The response time to an ACI command will depend on the type of ACI command and the activity status of the drive at the time the command is received.

Note that although the drive does not support ACI command queuing, queuing can occur in exceptional conditions, for example, if the automation controller had timed-out the tape drive's response to a command and either resent the command or sent another command. In such circumstances, the drive will not ignore the overlapped commands but will respond to every command package it had received.

An example of this may occur if the host issues a long SCSI ERASE command to the drive and the automation controller issues an Unload command. The drive will not respond to the Unload command until the long erase had completed. If the automation controller times out the drive's response to the Unload command and re-sends the command or sends another command, then it needs to be able to handle the response to the original Unload command as well as to the subsequent commands.

The following tables list the recommended ACI command time-outs for queued and non-queued commands.

Non-Queued ACI Commands

ACI Command	Recommended time-out value
Get Drive Info	5s
Get Drive Status	5s
Get Drive Configuration	5s
Get Error Info	5s
Get Buffer Size	5s
No Op	5s
Acknowledge Attention	5s

Queued ACI Commands

ACI Command	Recommended time-out value
ACI Load—immediate	5s
ACI Load—non-immediate (drive idle, unloaded)	300s
ACI Unload—immediate	5s
ACI Unload—non-immediate (tape loaded, at EOM, drive idle)	300s or 9000s depending on implementation strategy
Set Drive Configuration (tape loaded, at EOM, SCSI unload)	300s or 9000s depending on implementation strategy
ACI Reset—ACI bus	5s
ACI Reset—drive	5s
Set Baud Rate	5s

Treatment of Reserved Fields

To ensure forwards compatibility with future versions of the ACI, automation controller firmware should set any command fields labelled as 'Reserved' to zero. Likewise, the firmware should mask off any response fields labelled as 'Reserved' during the processing of tape drive responses. This will allow older versions of automation controller firmware to operate successfully with newer versions of tape drive firmware.

Recommended Power-Up Sequence

After power-up, we recommend that the automation controller wait until it has received at least one ASCII <ENQ> character from the tape drive before attempting a command-response transaction. HP Ultrium tape drives use a two-step power-up sequence and the drive sends <ENQ> to signal the transition between the steps. The drive sends the first <ENQ> within 500 milliseconds of exiting the reset state after receiving power.

Consider sending a Get Drive Info command as the first command, either packetized or primitive. This retrieves a variety of useful information identifying the tape drive, including the version of the ACI protocol that the drive supports.

During the second step of the power-up sequence, the tape drive will respond with BUSY status to all ACI commands except Get Drive Info and Get Error Info. The amount of time taken by this second step will vary widely depending on three factors:

- The presence or absence of a cartridge in the tape drive
- The position of the media if a cartridge is present
- The ability of the tape drive to access the cartridge memory if a cartridge is present

We recommend that the automation controller polls using the Get Drive Status command to monitor the completion of the power-up sequence. When the tape drive returns GOOD status to a Get Drive Status command, it has completed the power-up sequence.

If operating with a tape drive that supports ACI V4.1, we recommend that the automation controller synchronizes the tape drive's time stamping clock to its own using the Set Time command once the tape drive has completed the power-up sequence.

In some circumstances when responding to the first Get Drive Info command, the tape drive will fill every byte in the Manufacturing Date Code and Serial Number fields with FFh. The tape drive behaves this way when it receives the Get Drive Info command during the second step of the power-up sequence because it cannot access the EEPROM that stores this information at that time. The automation controller can retrieve the correct value for these fields with a second Get Drive Info command sent after the power-up sequence has completed.

Once the power-up sequence completes, the automation controller can configure the tape drive using the Set Drive Configuration command. Each

time a Set Drive Configuration command is sent, it is recommended that a Get Drive Configuration command is sent to double-check that the drive is configured correctly.

It is recommended that the Get Buffer Size command is sent to drive as part of the power-up sequence to determine the maximum burst buffer size and maximum receive/transmit package buffer sizes.

If a baud rate other than the default is to be used, then it is recommended that this is set during the power-up sequence using the Set Baud Rate command.

Recommended Load-Unload Configuration

The Set Drive Configuration command provides access to several features that alter the tape drive's behavior when loading or unloading cartridges. These give a large amount of flexibility in designing an automation controller.

Our experience suggests that certain configurations result in significantly fewer difficulties when integrating the HP Ultrium tape drive.

We recommend configuration with the Auto-Eject feature disabled. If Auto-Eject is enabled, the drive will eject a cartridge in a variety of cases not directly controlled by the automation controller. These include receiving a SCSI LOAD/UNLOAD command with the Load bit set to 0, various load failures (regardless of the method of instigating the load), completion of the image verification step when upgrading the tape drive's micro-code using a firmware upgrade cartridge, and completion of a head-cleaning cycle when using a cleaning cartridge. These ejects can result in both the automation controller and the tape drive losing track of the location of the cartridge.

We recommend configuration of the upgrade protect features enabled (the Upgrade Protect bit of the Set Drive Configuration command is set to 1). This will ensure that if a firmware upgrade cartridge is loaded inadvertently, the drive's micro-code will not be upgraded unnecessarily.

If requested, HP will alter the default settings for Auto-Eject, Auto-Load, Auto-Thread, Clean Protect, and Upgrade Protect features in your particular variant of the firmware.

Recommended Get Drive Status Polling Frequency

It is recommended that the polling frequency of a Get Drive Status command should be in the range 2–5s, particularly during cartridge loading and unloading. This frequency should be sufficient to capture state changes in the

drive while not adding significant processing overhead to the drive or automation controller.

ACI Commands That Affect Drive Streaming Performance

Commands that alter the state of the drive in some way will affect the performance of the drive when stream reading or writing. It is recommended that no command within the following set are sent to the drive while the drive is writing or reading as it would affect the data throughput to or from the drive:

- Load
- Unload
- Send Firmware Image
- Send Firmware Segment
- Reset
- Set Drive Configuration—if the Primary Interface (SCSI or FC) is reconfigured
- Send SCSI with the following opcodes:
  - Mog Select
  - Mode Select
  - Mode Sense
  - Request Sense
  - Read Attribute
  - Write Attribute

ACI Communications Retry

The ACI specifies a comprehensive packet retry mechanism. Under certain timing conditions, especially for automation controllers that use a single microprocessor and multiplex the ACI from one tape drive to another, the automation controller can receive a response packet from the tape drive that it does not need. When this situation arises, the automation controller should send a positive acknowledgement control character, <ACK>, to the tape drive and discard the packet. Since the tape drive receives the <ACK>, it will not re-send the packet.

Upgrading the Drive Firmware

There are three methods of updating the firmware in the tape drive:

Firmware Upgrade Via Tape

It is expected that firmware upgrades via tape will be done under the control of the library controller and the Operator Control Panel and independently of the host interface.

If the Upgrade Protect bit is set to 1 in the Set Drive Configuration command (which is recommended), the tape can be loaded into the drive in the usual manner, except that the ACI Load command must be sent to the drive and the Upgrade bit and Thread bit in byte 1 of the Load command must be set to 1.

If the Immediate Response bit in the ACI Load command is *not* set to 1 and the firmware upgrade failed (say due to an invalid image on the tape), the ACI Load command will report a CHECK CONDITION with appropriate sense key and additional sense.

If the Immediate Response bit *is* set to 1 and the firmware upgrade fails, the automation controller can detect the failure by noting that the Tape Activity field in the Get Drive Status response returns to Idle and the tape drive does not enter its ACI initialization procedure.

- While the drive is preparing to upgrade the firmware, it will report Tape Activity = “Code Update in Progress”.
- While it is actually upgrading the firmware, the drive will not respond to ACI commands.
- After the firmware upgrade has completed the drive will reset and send out an ENQ byte over ACI.

After performing a firmware upgrade via tape it is recommended that the library controller checks that an ENQ byte is sent by the drive after it power-cycles at the end of the firmware upgrade process and that the normal power-up ACI command sequence is followed to ensure that the drive is configured correctly and to verify the firmware version and ACI version.

Firmware Upgrade Via SCSI

The library controller will not have direct visibility if a firmware upgrade of the tape drive is initiated via SCSI, hence it is recommended that the controller monitors for the symptoms that a firmware upgrade is taking place or has taken place.

- While the firmware image is being sent to the drive via SCSI, the drive responds to ACI commands with status BUSY.
- While the drive is actually upgrading the firmware, it will not respond to ACI commands.
- When the firmware download is complete, the drive will reset itself and send an ENQ control character.

It is recommended that the same ACI command sequence is followed as if the drive had been power-cycled to ensure that the drive is configured correctly and to verify the firmware version and ACI version.

Firmware Upgrade Via ACI

Two methods exist for updating firmware via ACI:

- Using the Send Firmware Image command. The automation controller sends the firmware image in one data burst outside a normal packet.
- Using the Send Firmware Segment command. The automation controller sends the firmware image in multiple packets.

HP intends to make the Send Firmware Image command obsolete in a future version of the ACI. Please use the Send Firmware Segment command in all new development. See the ACI specification for further details of both commands.

When the firmware download is complete, the drive will reset itself and send an ENQ control character. It is recommended that the same ACI command sequence is followed as if the drive had been power-cycled to ensure that the drive is configured correctly and to verify the firmware version and ACI version.

Library Firmware Upgrade Via Tape

The ACI specification allows for upgrading the automation controller firmware via tape. This functionality is not supported in current releases of drive firmware and will be added at a later date subject to customer needs.

Handling Irregular Cartridges

The purpose of this section is to indicate what symptoms can be seen over the ACI if the host issues a MOVE MEDIUM command to the library when an irregular cartridge (such as a cleaning cartridge, an expired cleaning

cartridge, a Generation 3 or 4 cartridge or a defective data cartridge) is in the storage element.

The following descriptions assume that the Auto-Eject bit in the Set Drive Configuration command has been set to 0 so that the cartridge will not be ejected from the drive unless an ACI Unload command is issued with the Eject bit set to 1.

Cleaning Cartridge (HP-Configured or Universal)

When a valid cleaning cartridge (one that has not expired) is loaded, behavior depends on the Clean Protect bit of the Set Drive Configuration command.

Clean Protect = 1 If the Clean Protect bit is set to 1, the drive will not thread the tape or clean the drive until an ACI Load command with the Clean bit set to 1 is sent to the drive. If the Load command is sent without the Clean bit set the drive will return a CHECK CONDITION. Also, if the "cleaning cartridge" is not in fact a cleaning cartridge, the Load command with the Clean bit set to 1 will produce a CHECK CONDITION.

Clean Protect = 0 If the Clean Protect bit in the Set Drive Configuration command is set to 0, the drive will thread the tape and clean the drive when a cleaning tape is loaded.

When the cleaning cartridge is seated in the drive, the 'cartridge type' field in the Get Drive Status RDATA will be set to 06h (cleaning).

While the drive is cleaning, the Cleaning bit in the Get Drive Status RDATA will be set to 1 and the Tape Activity field will be set to Ah (cleaning).

When cleaning has finished, if Auto-Eject is disabled, the cartridge will be in the ready eject position with the Cartridge Present, Write Protect, Ready Eject, and Ready Load bits set to 1, Cartridge Type = 'Cleaning', and Tape Activity = 'Idle'. The cartridge can now be unloaded from the drive.

Expired Cleaning Cartridge (HP-Configured or Universal)

If an expired cleaning cartridge is loaded into the drive, the cartridge will be placed in the ready eject position with the Cartridge Present, Write Protect, Ready Eject, Ready Load, Media Error, TapeAlert, and Clean Expired bits set to 1, Cartridge Type = 'Cleaning', and Tape Activity = 'Idle'. TapeAlert flag 22 will be set.

Non-HP Cleaning Cartridge

If a non-HP cleaning cartridge is loaded into the drive, the cartridge will not be recognized as a supported cartridge. The cartridge will be placed in the

ready eject position with the Cartridge Present, Write Protect, Ready Eject, Ready Load, Media Error, and TapeAlert bits set to 1, Cartridge Type = 'Unknown', and Tape Activity = 'Idle'. TapeAlert flag 17h will be set.

Unreadable Generation 1 or 2 Data Cartridge

If a Generation 1 or 2 data cartridge is loaded that cannot be read, the cartridge will be placed at the hold point with the Cartridge Present, Write Protect, Ready Eject, Ready Load, Media Error, and TapeAlert bits set to 1, Cartridge Type = 'Unknown', and Tape Activity = 'Idle'. TapeAlert flag TBD will be set.

Generation 3 or 4 Data Cartridge

If a Generation 3 or 4 data cartridge is loaded into the drive, the drive will recognize the cartridge as a non-supported cartridge. The cartridge will be placed at the hold point with the Cartridge Present, Write Protect, Ready Eject, Ready Load, Media Error, and TapeAlert bits set to 1, Cartridge Type = 'Unknown', and Tape Activity = 'Idle'. TapeAlert flag TBD will be set.

Generation 1 or 2 Data Cartridge with Unreadable CM

If the Cartridge Memory cannot be read, the drive assumes that the cartridge is not supported. If the cartridge is loaded into the drive, the cartridge will be placed at the hold point with the Cartridge Present, Write Protect, Ready Eject, Ready Load, Media Error, and TapeAlert bits set to 1, Cartridge Type = 'Unknown', and Tape Activity = 'Idle'. TapeAlert flag 0Fh will be set.

Cartridge Fails to Seat or Load

If a cartridge fails to seat or load, the cartridge will be placed at the hold point with the Cartridge Present, Ready Eject, Ready Load, Media Error, and TapeAlert bits set to 1, Tape Activity = 'Idle'. TapeAlert flag TBD will be set. If the cartridge type is recognized, then this will be indicated in the Cartridge Type field, otherwise the field will indicate Cartridge Type = 'Unknown'.

Cartridge Cannot Be Loaded

It is recommended that GOOD status is not returned to the host for the MOVE MEDIUM command until the library controller has seen the Cartridge Load bit in the Get Drive Status RDATA set to 1. If the library controller does not see this bit set, it is recommended that an appropriate load re-try algorithm be invoked. After re-trying the load, if this bit is still not set to 1, assume that there is a problem with the cartridge. It is recommended that the library controller responds to the MOVE MEDIUM command with CHECK CONDITION

with a sense key of Not Ready and additional sense of 5300h (media load or eject failure) and then moves the cartridge back to the source element. If the Drive Error bit is set to 1 in the Get Drive Status RDATA, then appropriate actions should be taken.

Valid Firmware Upgrade Cartridge

If a Generation 1 or 2 firmware upgrade cartridge with a valid firmware image is loaded, and neither the library controller nor the host knows that the cartridge is a firmware upgrade cartridge, what occurs depends on the Upgrade Protect bit in the Set Drive Configuration command.

Upgrade Protect = 1 If the Upgrade Protect bit in the Set Drive Configuration command is set to 1, it is assumed that the Upgrade bit in the Load command will be zero and no firmware upgrade will be performed on the drive. The cartridge will be placed at the hold point with the Cartridge Present, Write Protect, Ready Eject, Ready Load, Media Error, and TapeAlert bits set to 1, Cartridge Type = 'Firmware Upgrade', and Tape Activity = 'Idle'. TapeAlert flag 10h will be set.

Upgrade Protect = 0 If the Upgrade Protect bit in the Set Drive Configuration command is 0, a firmware upgrade will be performed on the drive. While the drive is preparing to upgrade the firmware, it will report Tape Activity = "Code Update in Progress". When actually upgrading the firmware the drive will not respond to ACI commands. After the firmware upgrade has completed the drive will reset and send out an ENQ byte over ACI.

It is recommended that the library controller follows the normal power-up ACI command sequence after receiving the ENQ byte to ensure that the drive is configured correctly and to verify the firmware version and ACI version.

Invalid Firmware Upgrade Cartridge

If a Generation 1 or 2 firmware upgrade cartridge with an invalid firmware image is loaded, and neither the library controller nor the host knows that the cartridge is a firmware upgrade cartridge, again what occurs depends on the Upgrade Protect bit in the Set Drive Configuration command.

Upgrade Protect = 1 If the Upgrade Protect bit in the Set Drive Configuration command is set to 1, it is assumed that the Upgrade bit in the Load command will be zero and no firmware upgrade will be performed on the drive. The cartridge will be placed at the hold point with the Cartridge Present, Write Protect, Ready Eject, Ready Load, Media Error, and TapeAlert bits set to 1, Cartridge Type =

'Firmware Upgrade', and Tape Activity = 'Idle'. TapeAlert flag 10h will be set.

Upgrade Protect = 0 If the Upgrade Protect bit in the Set Drive Configuration command is set to 0, the firmware upgrade process will start and the drive will thread the tape and read the image. During this time, the drive will report Tape Activity = "Code Update in Progress". When the image has been read the drive will check whether the image is valid. As in this case the image is not valid, the drive will place the drive at the hold point with the Cartridge Present, Write Protect, Ready Eject, Ready Load, Media Error, and TapeAlert bits set to 1, Cartridge Type = 'Firmware Upgrade', and Tape Activity = 'Idle'. TapeAlert flags 10h and 22h will be set. The drive will not send out an ENQ byte and will not reset.

Frequently Asked Questions

The Automation Control Interface (ACI) allows the activities of the drive to be coordinated within a library. It provides several modes for operating HP Ultrium drives within tape libraries. In addition, the Cartridge Memory can, at the very minimum, provide an 'electronic barcode' facility to allow media tracking. HP is working with all the major tape library vendors to ensure that the full potential of these features are realized, and recognizes that ISV software support is a key part of this process. In advance of the release of the HP Ultrium Automation Cookbook, here are answers to some frequently asked questions:

Is there separate firmware for drives that are intended to go into libraries?

No. The firmware in standard HP Ultrium drives will function equally well in standalone drives, racks, autoloaders or libraries.

How does the automation LUN get to appear on the SCSI bus?

Firstly, there must be a device connected to the drive's ACI port that asserts a dedicated hardware line on the port. This helps the drive to know the difference between an attached library controller and, say, a network management interface. Secondly, the library controller must send a specific command to the ACI that asks the drive to make the automation LUN appear on the SCSI bus.

In a multi-drive library, will more than one automation LUN appear on the SCSI bus?

In a multi-drive library, the controller in the library is expected to send ACI commands to switch off the LUN's visibility of all but the 'primary' drive (the one that supports the automation LUN to which the host sends automation commands). This allows library controllers to manage their drives and to achieve a degree of hardware redundancy if the primary drive fails.

New features in ACI 4.1

Asynchronous Notification

This configurable mechanism allows the tape drive to alert the automation controller asynchronously of important conditions detected by the tape drive. The drive asserts the ACI_ATN_L line (See page 101) when the drive has detected one or more of the following conditions:

- CDB waiting (for Surrogate SCSI)
- Clean needed
- Clean Required
- Drive Error
- Media Error
- TapeAlert flag set

The tape drive de-asserts the ACI_ATN_L line when the underlying conditions causing the assertion no longer exist or when the automation controller acknowledges receipt of the conditions using an Acknowledge Attention command.

The ACI_ATN_L signal is an active low signal so the automation controller can use it as a level or edge-triggered interrupt signal. As an alternative, the ACI_ATN_L signal may connect to a general input port in the automation controller microprocessor and the automation controller firmware may poll this port at any desired frequency.

The automation controller can configure the tape drive to assert the ACI_ATN_L line for all or any combination of the conditions listed above. The automation controller configures the tape drive by setting the appropriate bits in byte 12 of the Set Drive Configuration command.

In addition to the asynchronous notification feature, the tape drive reports all of the conditions listed above when responding to a Get Drive Status command. As a result, an automation controller engineer may make design

trade-offs between asynchronous notification and Get Drive Status polling to detect the listed conditions. In general, we recommend using asynchronous notification in designs that use a low Get Drive Status polling frequency. Specifically, we recommend using asynchronous notification for conditions that the automation controller wishes to detect more quickly than one-half of the Get Drive Status polling period. See "Recommended Get Drive Status Polling Frequency" on page 33 for a discussion of the Get Drive Status polling period.

Configurable Response Period

This configurable mechanism allows the automation controller to limit the time the tape drive takes to respond to a command.

Typically, a tape drive will exhibit a degree of variability in the time it takes to respond to any given command. The variation occurs because of processing dependencies with other events and microprocessor bandwidth limitations in the tape drive. In extreme cases, the tape drive may require several seconds to respond to some commands (see "Recommended ACI Time-out Values" on page 30).

Automation controller designs that use a single microprocessor to communicate with multiple tape drives via a multiplexed connection may require tape drive responses within a fixed period. To meet that requirement, ACI 4.1 includes the configurable response period mechanism.

The response period mechanism allows the automation controller to limit the response period (that is, the maximum response time) in increments of 100 milliseconds. When a command exceeds the configured response period, the tape drive will respond to the command before command processing completes. The status field in the response packet indicates whether the command has caused a change in the state of the tape drive.

The automation controller may configure the response period using the Set Drive Configuration command.

Preservation of Drive or Media Error

If the tape drive experiences a hardware fault or a media fault, it will preserve Error Information that describes the fault condition until the drive process a Get Error Info command, a cartridge load occurs, or a tape drive reset occurs. Use the Get Error Info command to access the error information. The command returns a SCSI Sense Key, Additional Sense Code, Additional Sense Code Qualifier, and a proprietary error code.

Get Drive Status Enhancements

Cartridge Present Indicator

The position and meaning of the Cartridge Present indicator have changed from ACI 4.0 to ACI 4.1. The old Cartridge Present indicator still exists in bit 0 of byte 0 of the Get Drive Status RDATA and it still functions the same as in ACI 4.0, but the bit has been renamed to Ready Load. There is a new indicator in bit 6 of byte 0, which is called Cartridge Present. This takes advantage of a new cartridge present sensor added to the tape drive mechanism. The new Cartridge Present indicator becomes active when the tape drive detects the trailing edge of a cartridge within 50 mm of the front panel (that is within 55 mm of the front of the tape drive chassis).

Cartridge Type Field

When the tape drive contains a cartridge, this field indicates the type of cartridge present.

CDB Waiting Indicator

When active, this flag indicates that the tape drive has received a CDB on a Surrogate SCSI LUN. The automation controller can retrieve the CDB using the Get SCSI CDB command. The tape drive will not activate this flag unless the automation controller has configured the tape drive for Surrogate SCSI operation.

TapeAlert Indicator

When active, this flag indicates that one or more TapeAlert flags have changed state. The automation controller can retrieve the TapeAlert flags using a SCSI LOG SENSE command with page code of 2Eh encapsulated within a Send SCSI command.

Support for Write/Read Attributes for MAM (Media Auxiliary Memory)

An automation controller may access the MAM of a cartridge by encapsulating a SCSI READ ATTRIBUTE or WRITE ATTRIBUTE command inside of an ACI Send SCSI command. An automation controller has the same MAM access rights as a host.

When loading a cartridge solely to gain MAM access, we recommend that the automation controller turn off the auto-thread configuration and, if using the ACI Load command, leave the Thread bit off. This configuration will

minimize the length of time required to complete the load because the tape drive will not thread the media. Typically, non-threading loads complete in approximately one second.

Set/Get Time

The Set Time and Get Time commands provide a mechanism to synchronize the time stamps used in the tape drive's logs with those used in the automation controller's logs. Generation 1 HP Ultrium tape drives use a 32-bit time stamp that rolls over every 19 hours. Generation 2 drives use a 48-bit time stamp that rolls over once in approximately 140 years.

Further Details

For more information about ACI, see "Automation Control Interface (ACI)" in Chapter 1, "Ultrium Features", of **Background to Ultrium Drives**, Volume 6 of the HP Ultrium Technical Reference Manual.

Configuring Autoload and ACI-Controlled Loads

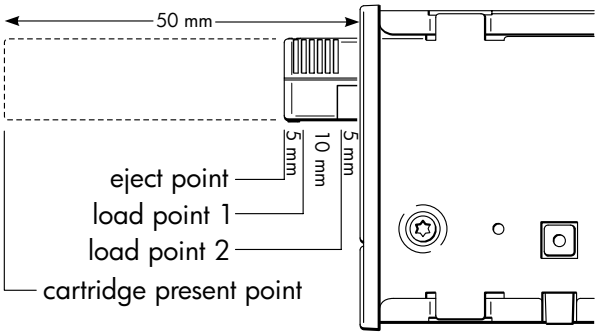
HP Ultrium tape drives can be configured so that loads either occur automatically or under the control of the ACI. A SCSI MODE SELECT command can set the Autoload field to do this. The field is byte 5, bits 0–2 of the Control Mode page, 0Ah.

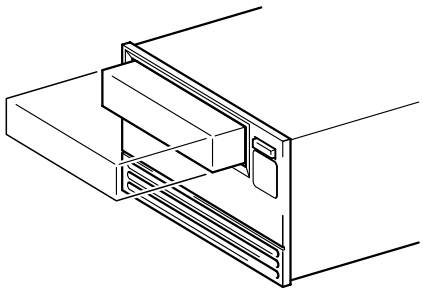
If the Autoload field = 0, Autoload is set and the drive automatically loads a cartridge when it is inserted and threads the tape so that it is ready for use.

If the Autoload field = 1 or 2, the drive pulls the cartridge into the drive but does *not* thread the tape. In this position, the LTO-Cartridge Memory can be read. The drive requires a Load command to thread the tape and make it ready for use.

Cartridge Positions During Load and Unload

The following diagram shows the positions of importance during load and unload.





Cartridge Present Point The drive detects the presence of a cartridge from this point onwards. The point is 50 mm beyond the front panel and 55 mm beyond the front of the mechanism. The automation controller cannot configure the location of this position.

Eject Point Cartridges are ejected to this point. It is 20±1 mm beyond the front panel. The automation controller cannot configure the location of this position.

Load Point 1 If Autoload is set (Autoload field = 0), the drive will start to load the cartridge when it reaches this point.

If Autoload is not set (Autoload field = 1 or 2), the library must insert the cartridge into the drive to a position between Load Point 1 and Load Point 2 and preferably closer to Load Point 1. The library can then issue a Load command over the ACI to instruct the drive to load and thread the cartridge.

The maximum speed for inserting a cartridge into the drive is 80 mm/s.

Load Point 1 is the recommended minimum load point for commanded loads. It is 15 mm beyond the front panel with a –2 mm tolerance.

Load Point 2 The maximum distance a cartridge can be inserted for optimal loading performance, so that autoload or a Load command can load the cartridge. It is 5 mm beyond the front panel. The automation controller cannot configure the location of this position.

The maximum speed for inserting a cartridge into the drive is 80 mm/s.

There is one other point of note, **Hold Point**. If Auto-Eject is not set then when an unload command is received by the drive, the tape will be rewound and unthreaded. The drive will then wait at this point until it is commanded to eject the cartridge by the ACI Unload command.

Load Scenarios

The following scenarios describe the operation during the various types of load.

Load Scenario 1: Autoload

1. The library sends an ACI Set Configuration command to enable Autoload.
2. The host sends a Move Medium command to the robotics.
3. The picker gets a cartridge from a storage slot.
4. The picker inserts the cartridge into the drive aperture.
5. The picker pushes the cartridge to at least Load Point 1.
6. The drive automatically takes the cartridge, loads it and threads it.

Load Scenario 2: ACI Controlled

1. The host sends a Move Medium command to the robotics.
2. The picker gets a cartridge from a storage slot.
3. The picker inserts the cartridge to between Load Point 1 and Load Point 2.
4. The picker lets go of the cartridge.
5. The library sends an ACI Load command to the drive.
6. The drive takes the cartridge, then loads and threads it.

Unload Scenario 1: Autoload

1. The library sends an ACI Set Configuration command to enable Auto-Eject.
2. The host sends a SCSI Unload command to the tape drive.
3. The drive rewinds, unthreads and ejects the cartridge to Eject Point.
4. The host sends a Move Medium command to the robotics.
5. The picker takes the cartridge from the tape drive and places it in its storage slot.

Unload Scenario 2: ACI Controlled

1. The host sends a SCSI Unload command to the drive.
2. The drive rewinds and unthreads the tape. It then pauses with the cartridge at Hold Point.

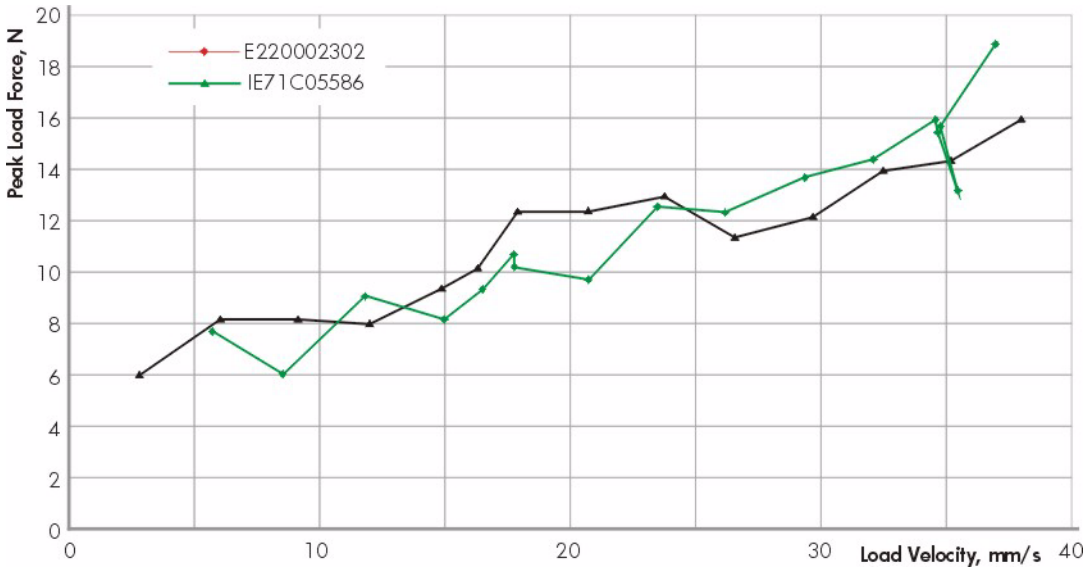
3 The library sends an ACI Unload command to eject the cartridge.

4 The drive ejects the tape to Eject Point.

5 The picker takes the cartridge from drive and places it in its storage slot.

6 Load Forces

7 The unload force is 4.45N maximum. The peak load force varies according to the speed at which the cartridge is inserted into the drive. The peak load force occurs when the cartridge begins to accelerate the drive carrier and only lasts for a short time. The following graph plots two examples of peak load force against load speed:



Using Cartridge Memory (LTO-CM)

See "Use the following table to resolve cleaning problems:" on page 26 for troubleshooting suggestions.

Linear Tape Open—Cartridge Memory (LTO-CM) is EEPROM memory that is embedded in every Ultrium tape cartridge. It is non-volatile and is contactless in that it is read by inductive coupling rather than electrical contact.

The Cartridge Memory is used to store the tape directory and diagnostic and log information. Because of the speed at which it can be read, load and

unload times are reduced, information is found on the tape more quickly and fewer tape passes are needed, increasing tape reliability.

The memory is primarily designed to speed up internal operations in the drive, but it also contains free space that can be used by application software. Of the 4 kilobyte memory, about 1 kilobyte is free space. This may be used to store "common" information (shared by all software vendors) and "vendor-unique" information (specific to the application).

Hosts can use this free space using the SCSI Write Attribute and Read Attribute commands. For information on these commands, see Chapter 4 of **The SCSI Interface**, Volume 3 of this HP Ultrium Technical Reference Manual.

For more information on LTO-CM, see "LTO Cartridge Memory" in Chapter 5 of **Background Information**, Volume 6 of this HP Ultrium Technical Reference Manual.

To support CM fully, software vendors should ensure that their company names are registered with ANSI T10 or the National Committee for Information Technology Standards (NCITS) as they are now known. The list of Vendor IDs is displayed at http://www.t10.org/lists/vid-alph.htm, which also contains details of how to get a new name assigned.

Cartridge Memory adheres to the Media Auxiliary Memory (MAM) standard. "MAM" indicates that the access method applies to all types of media, not just Ultrium.

The MAM standard provides for the storage and access of information held as a set of pre-defined and user-definable attributes that are divided into six main sections:

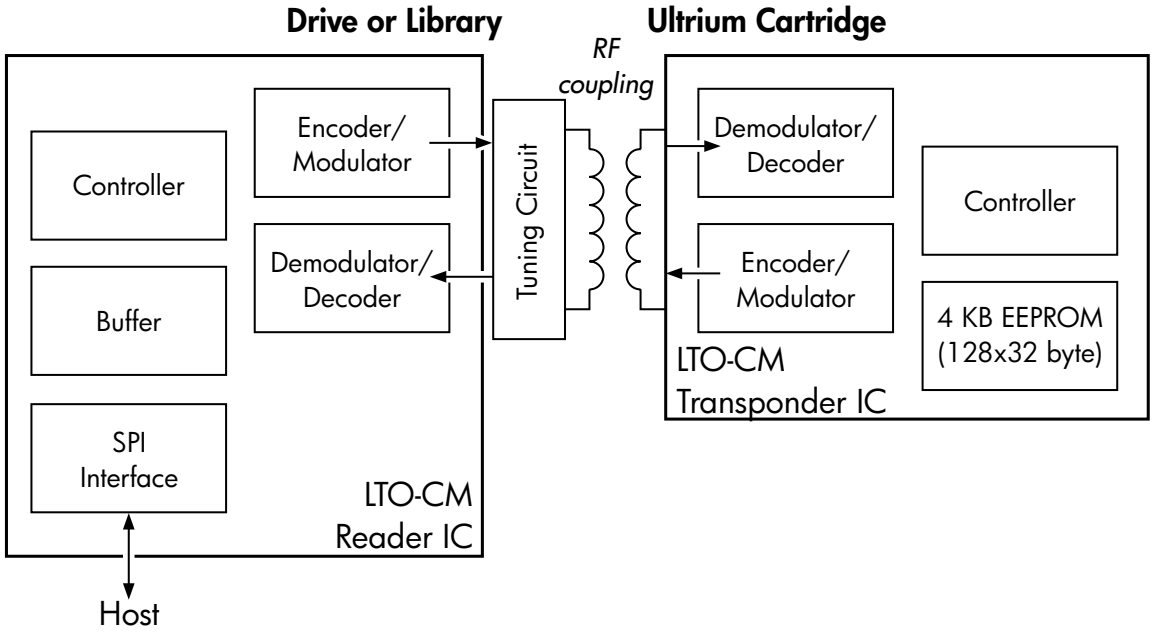
- Media Common Section—hard-coded by the media manufacturer.
  For example: manufacturer's name, cartridge serial number, length, media type
- Drive Common Section—updated by the drive every time it accesses the media.
  For example: maximum and remaining tape capacity, TapeAlert flags
- Host Common Section—updated by the host's software application every time it uses the media.
  For example: software application vendor's name and version, media text label, date last written
- Media Vendor Unique Section—optional information written by the media vendor for their own purposes. Unique to the media vendor.

- Media Vendor Unique Section—optional information written by the media vendor for their own purposes. Unique to the media vendor.
- Host Vendor Unique Section—space reserved for use by software applications for their own purposes. Unique to the software vendor. Approximately 1 kilobyte.

For details of SCSI commands relating to Cartridge Memory or MAM, see Read Attributes (8Ch) and Write Attributes (8Dh) in the SCSI Guide.

Use in Libraries

Cartridge memory offers possibilities for use in libraries as an adjunct to or replacement for barcodes. The following diagram shows the architecture required. HP is working to provide a standard module with this functionality via a third party.



Current Libraries — Barcodes

Many libraries use sticky labels with barcodes on cartridges to identify them. These are read by a barcode reader attached to the picker arm. The

application then needs to hold information as to the contents of the tape to which it can relate the bar code.

Cartridge Memory can be used as a substitute for these barcodes. No human interaction is needed to fix barcode labels, reducing errors, though cartridges may still need labels that humanS can read. A cartridge can be identified by its serial number.

However, because Cartridge Memory has space that can be written by applications, it can hold details of the contents and nature of the tape. This obviates the need for this information to be held by the application

HP is working with other industry leaders, both hardware and software, on an Industry Common Implementation Guide.

For more details of cartridge memory, see "Using Cartridge Memory (LTO-CM)" on page 47.

More Information

- For more details, see "LTO Cartridge Memory" in Chapter 4, "Cartridges", of **Background to Ultrium Drives**, Volume 6 of the HP Ultrium Technical Reference Manual.
- The latest version of the specification is incorporated into SCSI SPC-3.
- The access specification can be found at http://www.t10.org/.

Drives in Tape Arrays

3

Identifying the Drive

The model name is on the front panel and the product and serial numbers are on the side of the drive.

Installing Drives

Modes of Usage

Tape arrays can be used in different system configurations; direct attach, network attach and attached to a Storage Area Network (SAN). For details of these see page 103.

Attaching to Fibre Channel

If you are installing on a fibre channel direct attach, network or SAN configuration, you will need a fibre channel/SCSI router. Check the www.hp.com website for the latest ordering information. This manual does not describe how to configure your fibre channel infrastructure or SAN network to use the tape array. This is a complex area and users are advised to refer to their SAN documentation or contact their SAN system administrator or supplier for technical support.

Attaching to SCSI

HP Ultrium drives are high performance Ultra3 SCSI devices designed to operate on a low voltage differential SCSI bus (LVDS). They are installed in a tape array in a rack-mount system and can be connected to a SCSI connection on a server or fibre channel/SCSI router. To get optimum performance from

your tape drive you need a SCSI bus that can transfer data at a rate that supports the tape drive's maximum transfer speed. We recommend an Ultra3 (160) or Ultra4 (320) SCSI bus.

Before starting to install your tape drive, you should consider the following points.

Appropriate HP Rack-Mount Systems

HP Ultrium removable tape drives are used in conjunction with:

- the **HP StorageWorks H/A Tape Array 5500** system, which will hold up to five full-height tape drives
- the **HP StorageWorks Tape Array 5300** system, which will hold up to two full-height drives

The tape array is designed to be installed into HP, IBM and other compatible 19" rack-mount systems. It must be properly installed and configured. Refer to your tape array documentation for further details.

Airflow Requirements

As long as the tape array is fully populated, it will provide adequate airflow for HP Ultrium drives.

If you have unused bays in the tape array, you must install the blanking plates provided with the tape array. This ensures that there is adequate airflow to the drives. See the documentation with the tape array for details on installing blanking plates.

You should ensure that ventilation is adequate at the front and rear of the tape array.

HP Ultrium drives require forced airflow, either from front to back or from back to front. The required flow depends on the ambient air temperature:

- 8 cfm for ambient air temperatures fluctuating in the range 10°–40°C.
- 6 cfm for ambient air temperatures fluctuating in the range 10°–35°C.

Setting the SCSI ID

For removable drives installed in a HP StorageWorks H/A Tape Array 5500 or HP StorageWorks Tape Array 5300 rack enclosure, set the SCSI ID at the appropriate switch on the rear of the tape array. Each drive should have a unique ID. The number of address switches corresponds to the number of tape drives that can be inserted into the tape array. For example, there are five

address switches on the HP StorageWorks H/A Tape Array 5500. The HP StorageWorks Tape Array 5300 has four SCSI ID switches to enable the installation of up to four half-height tape drives. When installing two HP Ultrium full-height tape drives, use the SCSI ID switches 1 and 2 only.

Termination

Both ends of a SCSI bus must be terminated.

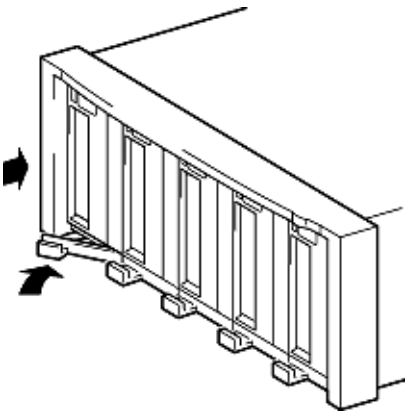
Assuming that the host bus adapter is already correctly terminated, there are typically two possibilities:

- The tape drive is being connected in a direct one-to-one configuration to the host server—termination must be used.
- The tape drive is being daisy-chained with other tape devices onto the host server—only the last device must be terminated.

The terminator can be plugged directly onto either of the two SCSI connectors on the rear of the tape array. Terminators must be ordered separately.

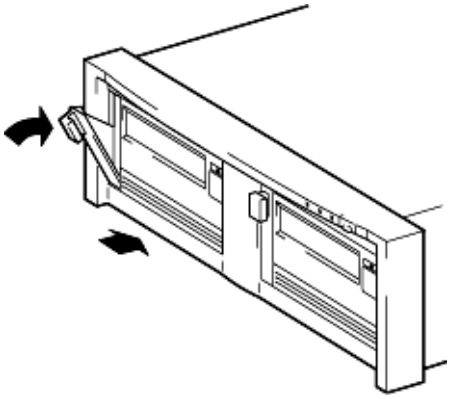
Inserting a Drive

In an HP StorageWorks H/A Tape Array 5500



1. Ensure that the extractor lever on the drive is in the out position, as shown in the picture.
2. Lift the drive carefully and turn it so that it is on its side with the extractor lever at the bottom.
3. Align the rear of the drive with the guides on the bottom of the HP StorageWorks H/A Tape Array 5500.
4. Slide the drive along the guides until the connectors on the back mate with the connectors at the back of the enclosure.
5. Push the extractor lever in until it locks the drive in position.

In an HP StorageWorks Tape Array 5300



1. Ensure that the extractor lever on the drive is in the out position, as shown in the picture.
2. Lift the drive carefully.
3. Align the rear of the drive with the guides on the side of the HP StorageWorks Tape Array 5300.
4. Slide the drive along the guides until the connectors on the back mate with the connectors at the back of the enclosure.
5. Push the extractor lever in until it locks the drive in position.

Connecting to a Fibre Channel Router or by SCSI to a Serverrouter

The individual tape drives are connected to their host server or fibre channel router via the high density LVD/SE SCSI connectors on the back of the tape array. They do not require any SCSI cables to plug into the tape array. However, cabling and terminators are required to connect the tape array with the SCSI host.

Fibre Channel Connection

If you are using your tape drive on a fibre channel (FC) network, you will need a FC/SCSI router with a spare LVDS SCSI port. The router should be connected via a 68-pin, wide, LVDS-rated cable to the tape array. Refer to our web site at `www.hp.com/go/connect` for details of recommended FC/SCSI routers and cables. If you are attaching your tape drive to a SAN environment supplied by HP, refer to your SAN solution collateral or configuration guides for further details.

Server SCSI Connection

If you are attaching the drive to a server, you will need a properly installed and configured SCSI host bus adapter (HBA) or a built-in SCSI controller on your server with a spare LVDS SCSI port. For optimum performance your tape drive should only be connected to an Ultra3 (160) or Ultra4 (320) host bus adapter or SCSI controller.

The server should be connected via a 68-pin, wide, LVDS-rated cable to the tape array. The standard, recommended configuration is a direct, one-to-one

SCSI connection between the tape drive and the host server so that the drive is the only device on the SCSI bus. It is possible to daisy-chain two tape drives together within the tape array, but this should only be done if the drives are on an Ultra4 (320) SCSI bus. Do **not** daisy-chain more than two drives together, as this will degrade their individual performance with respect to transfer rate.

Do **not** attach the drive to the same SCSI bus as your disk drive or RAID controller.

Replacing a Drive

HP Ultrium removable drives can be removed and replaced without powering down the tape array and without interrupting operations to the other drives in the array. However you should be aware of the following:

- In Berkeley mode, the tape position will remain unchanged by a device close operation.
- In AT&T mode, a device close operation will cause the tape to be repositioned just after the next tape filemark (the start of the next file).

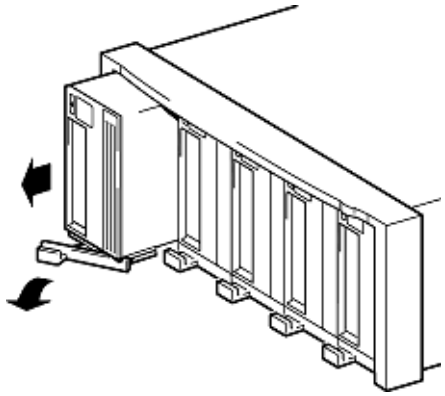
If all drives in the tape array are powered up when the system is turned on, the host will be aware of those drives. You can remove any of those drives and replace it with another drive without disrupting the system.

If a drive is not powered up or you place a drive in an empty slot after the system has been powered up, the system will have to be reset before the host will recognize the drive.

Removable drives allow modules to be replaced while powered up as long as no data is being transmitted from the system to the module or vice versa. The SCSI IDs are controlled by the tape array, not by the drives themselves, so if you remove a drive and replace it with another the ID will not change.

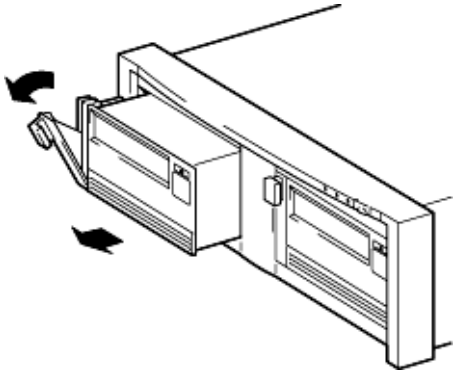
Removing a Drive

From an HP StorageWorks H/A Tape Array 5500



1. Pull the extraction lever of the drive that you want to replace so that it is in the out position.
2. Using the extraction lever, pull the drive gently and firmly out of the tape array.

From an HP StorageWorks Tape Array 5300



1. Pull the extraction lever of the drive that you want to replace so that it is in the out position.
2. Using the extraction lever, pull the drive gently and firmly out of the tape array.

Installing a New Drive

See the instructions in "Inserting a Drive" on page 53.

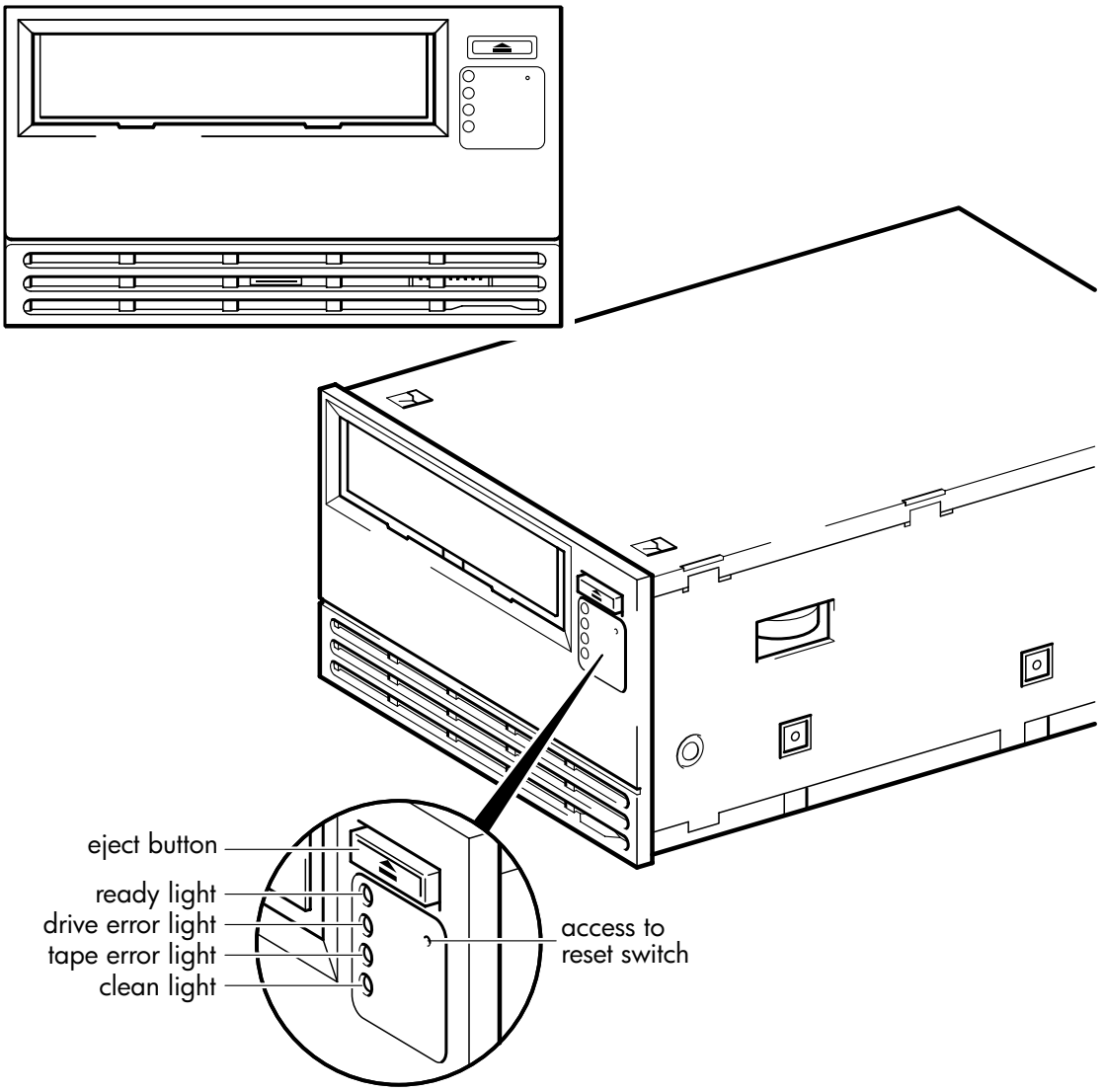
Operating the Drive

Removable drives are powered on when you switch on your tape array and computer.

The tape drive will run its hardware self-test, which takes about 5 seconds. During the test the 'Ready' LED flashes and all the other LEDs are off. On successful completion the 'Ready' LED is on. If the self-test fails, the 'Drive Error' and 'Tape Error' LEDs flash, while the 'Ready' and 'Clean' LEDs are off. This continues until the drive is reset.

- If you have just installed the drive, check the installation for loose connections, reset the drive and repeat the self-test.
- Try the "Troubleshooting" on page 61 to determine what the problem is.
- If the fault condition persists, call for assistance.

Front Panel Features



LEDs

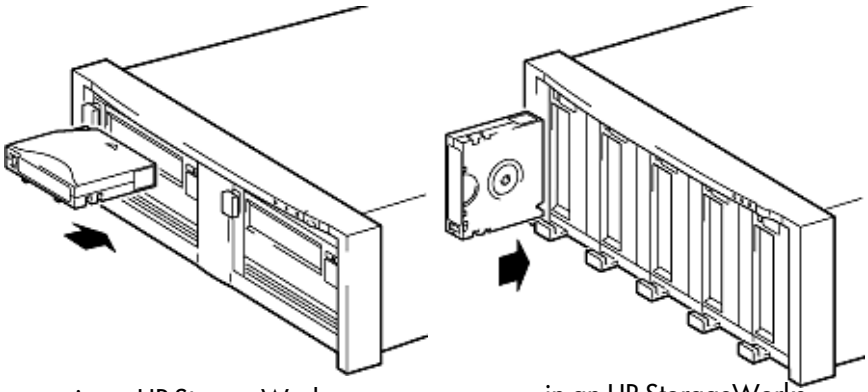
For details of the front panel LEDs, see page 93.

Reset Switch

The emergency reset switch allows you to reset the drive without powering off the drive and computer, for example if the drive stops responding. Access to the switch is through a small hole. It can be activated by a thin object, such as the end of a straightened paper-clip.

Loading a Cartridge

Use HP Ultrium cartridges with your drive.



in an HP StorageWorks Tape Array 5300

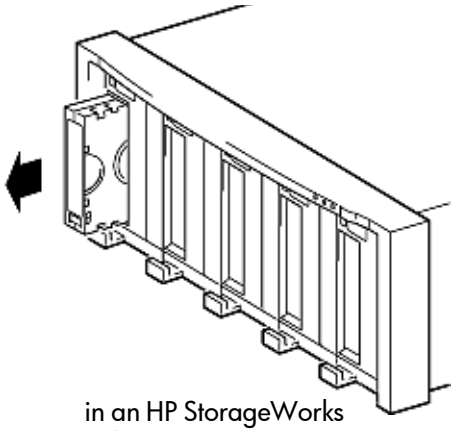
in an HP StorageWorks H/A Tape Array 5500

1. *In HP StorageWorks Tape Array 5300:*
   Insert the cartridge into the slot in front of the drive with the white arrow on the top facing the drive door. The toothed drive hub is on the bottom of the cartridge.
   In HP StorageWorks H/A Tape Array 5500:
   With this tape array, rotate the cartridge to match the orientation of the drive in the tape array. Insert the cartridge into the slot in front of the drive with the white arrow on the left-hand side facing the drive door. The toothed drive hub is on the right-hand side.
2. Apply gentle pressure on the rear of the cartridge until the drive takes the cartridge and loads it.

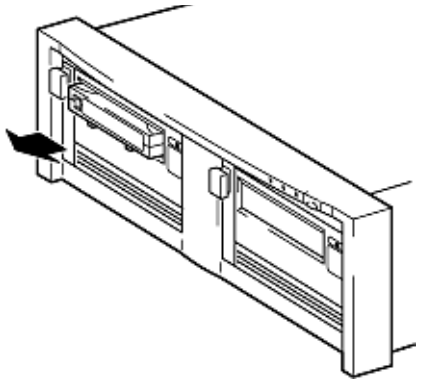
The 'Ready' LED flashes green while the drive performs its load sequence. When the cartridge is loaded, the 'Ready' LED shows steady green.

Do not try to force the cartridge if it does not load properly. The drive will eject the cartridge after about 10 seconds so you can load it again.

Unloading a Cartridge



in an HP StorageWorks H/A Tape Array 5500



in an HP StorageWorks Tape Array 5300

1. Press the Eject button on the front panel.
   During the unload sequence the 'Ready' LED flashes green. The drive completes any task it is currently performing, winds the tape to the beginning and ejects the cartridge. Once the tape has rewound, the eject cycle will take less than 13 seconds.
2. Remove the cartridge and store it in its plastic case in a cool, dry atmosphere.

Cleaning the Drive

Caution It is essential to use only Ultrium cleaning cartridges with HP Ultrium tape drives as other format cleaning cartridges will not load and run. Use of HP cleaning media will ensure your tape drive is fully protected.
Do not use swabs or other means of cleaning the heads.

When the drive needs cleaning, the orange 'Clean' LED on the tape drive will flash. Only insert a cleaning cartridge into the tape drive when the LED flashes.

The drive's TapeAlert feature will send a message to your backup application when the tape heads need cleaning or a cleaning cartridge has expired.

A cleaning cartridge can be used up to 50 times.

To clean the heads:

1. Insert a cleaning cartridge into the drive. The tape drive automatically loads the cartridge and cleans the heads.

   If the cleaning cartridge ejects immediately, it has expired or it is not an Ultrium cleaning cartridge (or is an older Ultrium Generation 1 cleaning cartridge manufactured by a vendor other than HP). In this case, discard the cleaning cartridge and repeat the operation with a new one.

   The cleaning cycle can take up to 5 minutes. During it the orange 'Clean' LED will be on and the green 'Ready' LED will flash. When it has finished, the drive ejects the cartridge.

2. Remove the cleaning cartridge from the drive.

Troubleshooting

Emergency Unload

If a cartridge fails to eject using the normal unload procedure, press and hold the Eject button for 10 seconds. This will instruct the drive mechanics to perform an emergency unload. Wait for the cartridge to be ejected. This process may take up to 15 minutes (the maximum rewind time).

If the cartridge is still jammed, press the emergency reset button (see page 59). Wait for the drive to reset and get back to the loaded position. This process may take up to 15 minutes (the maximum rewind time). Again press and hold the Eject button for 10 seconds to perform an emergency unload.

General Guidelines

The first step in problem-solving is establishing whether the problem lies with the cartridge, the drive, the host computer and its connections, or with the way the system is being operated.

Most modern SCSI host bus adapters locate and display attached devices when the system is booting up. On Windows systems, if you swap or connect a product when your system is running, you will need to reboot the system. IA32 systems also usually need to be rebooted. UNIX systems may have pluggable drivers, which allow drives to be attached to a running system and detected without rebooting.

If the device is not detected on boot up, there is probably a problem with the physical hardware: cables, termination, connections, power or the host bus adapter itself. If the device is displayed during boot up but cannot be found in the operating system, this is more likely to be a software problem.

Problems with the Host Computer

Most modern SCSI host bus adapters locate and display attached devices when the system is booting up. If the device is not detected at this stage, there is probably a problem with the physical hardware: cables, termination, connections, power or the HBA itself.

If your drive is found on system boot up but cannot be found in the operating system, this is more likely to be a software problem.

Computer does not boot up

Possible Cause	Potential Solution
You have connected the tape drive to an existing SCSI bus that has other devices connected to it and the SCSI address of the drive is identical to the address used by another device.	Make sure that each device on the SCSI bus has a unique ID. We recommend that the tape drive is connected to a dedicated host bus adapter. Do not connect the drive to a disk RAID controller as this is not supported.
You have installed an additional SCSI host bus adapter and its resources are clashing with an existing adapter.	Remove the new host bus adapter and check the server documentation.
You have disconnected the power or SCSI cable from the computer's boot disk during the drive installation process.	Check that the cables to all devices are firmly connected.

Computer boots, but does not recognize the drive

Possible Cause	Potential Solution
The power or SCSI cable is not connected properly.	Check that the cables to the tape drive are firmly connected. Ensure that the SCSI cable is LVDS-compliant and that it does not have any bent pins. Replace, if necessary.
The SCSI bus is not terminated correctly.	Check that the SCSI bus is actively terminated. (Refer also to the documentation for your SCSI controller and any other SCSI devices you may have.)

Possible Cause	Potential Solution
The tape drive's SCSI ID address is not unique.	Make sure that each device connected to the SCSI controller has a unique SCSI ID. Remember that 7 is normally reserved for the host bus adapter.

Problems with the Drive and Cartridge

Tape drive does not work

Possible Cause	Potential Solution
The drive is not receiving power from the tape array.	■ Check that the tape array is connected to a power source and switched on. ■ Check that the drive is properly inserted into the tape array so that it mates with the connections at the rear of the enclosure. The extraction lever should be pushed in, locking the drive in position. ■ If the drive 'Ready' LED is still off, call for assistance.
There is a fault with the drive.	If possible, and if no other drives in the tape array are in use, try resetting the drive, or turning the power switch on the tape array off and then on again. (If there is a tape cartridge loaded in the drive, try to unload it by pressing the Eject button. If this succeeds, switch the tape array off and then on again. If the problem persists, call for assistance.

The computer no longer recognizes the drive

Possible Cause	Potential Solution
You powered up the drive or added it to the tape array after the host system was turned on.	The host computer system only identifies which IDs are present on SCSI buses after power-on or a reset. To make the host look for devices on the bus, you need to reset the host. You should be able to do this using the SCSI management software on your computer. As a last resort, you could turn the host system off and on again.
You changed the drive's SCSI ID after the host system was turned on.	■ If you have replaced a drive that was recognized by the host, the host should recognize the new drive at the same SCSI ID as its predecessor. ■ If you make any changes to SCSI IDs (on the back on the tape array), you need to reset the bus for the host to recognize the changes.

Possible Cause	Potential Solution
The drive is not inserted correctly.	Check that the drive is properly inserted into the tape array so that it mates with the connections at the rear of the enclosure. The extraction lever should be pushed in, locking the drive in position.
The SCSI bus is not terminated correctly.	■ Check that the SCSI cable from the tape array is firmly connected to the SCSI connector in the computer. ■ If there are other devices in the SCSI bus, make sure that each device has a unique ID. ■ If there is more than one SCSI bus attached to your system, check that the system is looking for the drive on the correct SCSI bus. ■ Make sure that the bus is terminated correctly. If the array is the only device or the last device on the bus, it must have a terminator fitted. If some other device is last on the bus, it should have a terminator fitted and the tape array should not.
There is a fault with the host system.	■ Make sure that the system is configured to recognize the correct device at each SCSI ID. ■ Ensure that the correct driver for the tape drive is installed. Look at the SCSI host adapter documentation and backup software documentation for further advice.

The application does not recognize the drive

Possible Cause	Potential Solution
The application does not support the tape drive.	Check that the drive is installed properly. Refer to our World Wide Web site (www.hp.com/go/connect) for details of backup applications that support HP Ultrium tape drives. Load any service packs as necessary.
Some applications require drivers to be loaded.	Check that the correct SCSI and tape drive drivers are installed. Consult the backup application's installation notes for details.

The cartridge will not eject

Possible Cause	Potential Solution
The cartridge is jammed in the drive, or the backup application cannot eject the cartridge. This is most likely to be a communication problem between the drive and the system.	Check there is power to the drive. Press and hold the Eject button for 10 seconds. Allow the drive up to 15 minutes to eject (this is the maximum rewind time of the cartridge.) If the cartridge is still jammed, reset the drive (see page 59). Allow 15 minutes for the drive to return to the loaded position. Press and hold the Eject button for 10 seconds to eject the cartridge from the reset drive. If the cartridge is still jammed, call for support.

The drive will not accept a cartridge or ejects it immediately

Possible Cause	Potential Solution
The cartridge may have been damaged, for example dropped, the cartridge memory may be corrupted or the drive may have a fault.	1 Check that the drive has power (the power cable is properly connected and the ready LED is on). 2 Check that you are using the correct media. See Chapter "9" on page 107. 3 Make sure that you have loaded the cartridge with the correct orientation (see "Front Panel Features" on page 58.) 4 Check for damage to the media (to the cartridge case, leader pin or cartridge teeth) and discard it if it is damaged. 5 Use another cartridge that you know is good and see if it loads. If it does, the original cartridge is faulty and should be discarded. 6 Check if another drive will accept the cartridge. If it does, the original drive may be faulty. Before calling customer service, please check that the tape drive is responding and that it can be seen on the SCSI bus.

Internal Drives in Servers

4

For the physical specification of the drive, see Chapter 1, "Physical Specification" in **Specifications**, Volume 4 of the Ultrium Technical Reference Manual.

If you are installing the tape drive on a UNIX system, refer to the **UNIX Configuration Guide**, Volume 6 of the Ultrium Technical Reference Manual.

Installing an Internal Drive into a Server

Full details of how to install an internal Ultrium tape drive into a server drive bay is given in the Getting Started Guide:

- Full-Height Generation 2 Ultrium Internal Drive, Getting Started Guide

Identifying the Model

The model name is on the front panel and the product and serial numbers are on a label on the top of the drive.

Standards and Safety

Use the drive only in equipment where the suitability of the combination has been determined by an appropriate certification organization (such as Underwriters Laboratories Inc. or the Canadian Standards Association in North America, and the British Standards Institution or Verband Deutscher Elektrotechniker in Europe). Other considerations include the following:

1. A drive must be installed in an enclosure to limit an operator's access to live parts, to provide system stability, and to give the drive the necessary grounding integrity.
2. A drive must only be supplied by a Safety-Extra-Low-Voltage (secondary) circuit in accordance with DIN VDE 0805. During incorporation of the

equipment, all requirements of DIN VDE 0805 must be observed and obeyed.

Note The drives are only fused to protect them from excessive currents.

Requirements

Mounting Requirements

Drives require one industry standard 5¼-inch, full-height bay.

HP recommends 0.3 mm mounting clearance around all covers for isolation mounting movement.

For many servers, no mounting tray or rails are required. Devices simply slide into the computer's chassis and are fixed with screws. Other servers have built-in trays or rails. Yet others require a special mounting tray or rails to fix the drive into the empty bay.

Airflow and Cooling

HP Ultrium drives require forced airflow, either from front to back or from back to front, that satisfies the following conditions:

- For full-height internal drives, the airflow at 35°C ambient air operation should be at least 6 cubic feet per minute (0.17 cubic meters per minute or 10.19 cubic meters per hour) through the product. At 40°C, it should be at least 8 ft^3/min (0.23 m^3/min or 13.60 m^3/h)

These requirements and the operating temperature specification should keep the internal temperature around the media to less than 45°C and ensure reliable operation.

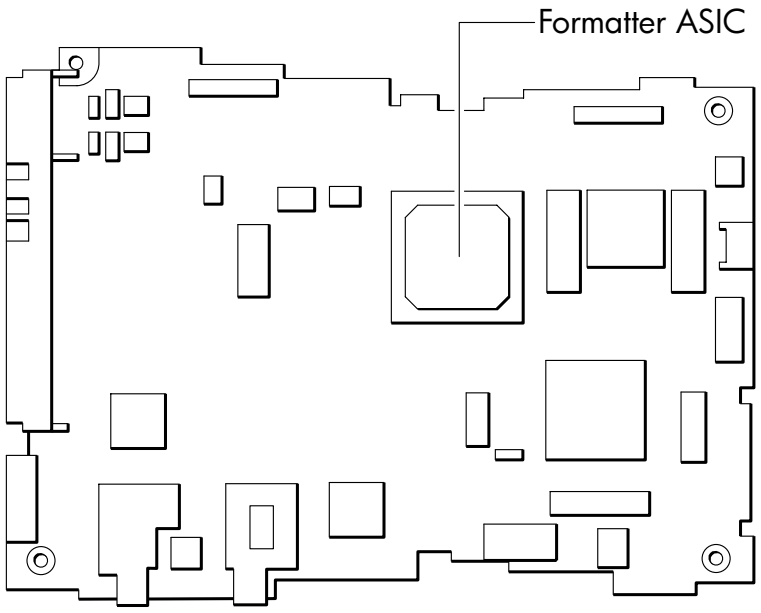
The airflow does not require filtering if the air contamination specifications are met. See "Climatics" in Chapter 4, "Environmental Specification" in **Specifications**, Volume 4 of the Ultrium Technical Reference Manual.

Caution Care must be taken that empty bays in the server have the appropriate blanking plates installed so that airflow is maintained. Refer to your server documentation.

How to Measure Critical Internal Drive Temperatures

The most accessible place to measure internal temperatures to ensure that airflow is adequate is the case lid of the Formatter ASIC (U6):

heat-sinks removed



Use a properly-applied, thermally-conducting epoxy adhesive to attach the thermocouple in order to ensure that the case-lid temperature measurements are accurate.

Start the drive stream-writing for a period of at least one hour, monitoring component U6 case lid temperature during the write operation. Monitor also the ambient air temperature.

Component U6 should not exceed 25°C over the ambient air temperature. For example, for an ambient temperature of 25°C, U6 case lid should remain under 50°C.

Power Requirements

The following are the PSU requirements:

Voltage	Typical Current	Maximum Current
5 V	3.2A	3.6A
12 V	0.7A	2.7A (drive reposition)

See also details in Chapter 2, "Electrical Requirements" in **Specifications**, Volume 4 of the Ultrium Technical Reference Manual.

The drive is specified to operate at 5V ± 5% and 12V ± 10%.

Specification	5V	12V
Maximum voltage	5.25V	13.2V
Minimum voltage	4.75V	10.8V
Maximum steady-state current	3.5A	1.0A
Maximum transient current	3.5A	2.5A
Maximum steady-state power	17.5W	12W

Server Connections

You need a properly installed and configured SCSI host bus adapter (HBA) or a built-in SCSI controller on the server.

The drives are Ultra3 wide, SCAM-1 compliant SCSI devices designed to operate on a low voltage differential SCSI bus (LVDS). LVDS interfaces enable longer cable lengths compared with single ended SCSI and Ultra3 supports a maximum bus speed of 160 MB/s (as opposed to 80 MB/s with Ultra2 and 40 MB/s with single-ended SCSI). Therefore, we do not recommend installing the drive onto an Ultra2 or single-ended bus or onto a bus with other Ultra2 or single-ended devices, as this may restrict performance. Similarly, do not install the drive onto a narrow SCSI bus, as this will restrict performance.

For optimum performance, always install the drive on a LVDS bus and use a dedicated host bus adapter for the tape drive.

Do not connect to a RAID controller channel; these are for disk drives only. Consult your supplier for details.

For an internal drive, you will need:

- Ultra3 (160) or Ultra4 (320) SCSI host bus adapter or server's embedded HBA
- LVDS-compliant SCSI ribbon cable with termination (normally supplied with the host bus adapter)
- A full-height 5¼-inch mounting bay
- Mounting hardware, if required
- Backup software that supports the tape drive

Supported Bus Types

SCSI Bus Type	Transfer Speed	Supported
Ultra3 (160) LVD	Up to 160 MB/s	Yes. This is the recommended configuration.
Ultra4 (320) LVD	Up to 320 MB/s	Yes. This is the recommended configuration for more than one drive per bus.
Ultra2 LVD	Up to 80 MB/s	Yes, but this will not provide optimum performance.
Single-ended, wide	Up to 40 MB/s	Yes, but this is not recommended as it will severely restrict performance. Do not connect to a narrow SCSI bus.
High Voltage Differential	Up to 40 MB/s	No. The drive will not work and you may damage the drive or controller

Fixing Dimensions

The positions of fixing points are shown below.

If the screw length used is too long, a mechanical limitation device on half-height drives will cause the screw to rotate without further tightening. This is to protect the internal mechanism. If this happens, place a washer behind the screw head (or use a shorter screw) to secure the mounting. The recommended screw length depends on the thickness of the rails or enclosure into which the drive is mounted:

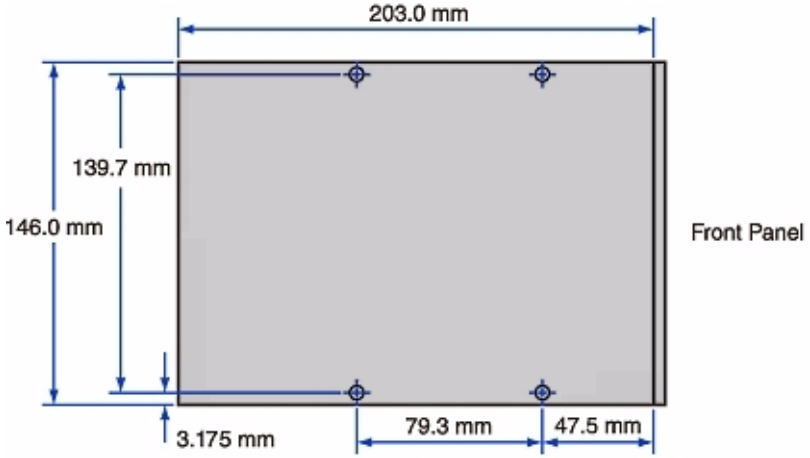
	Recommended Screw Length	
Server or Rail Thickness	Half-height drives	Full-height drives
> 1.5 mm ≤ 2.0 mm	M3 x 4.0 mm	M3 x 6.0 mm
> 1.0 mm ≤ 1.5 mm	M3 x 4.0 mm with 0.5 mm washer	M3 x 6.0 mm
≤ 1.0 mm	M3 x 3.0 mm	M3 x 5.0 mm

All screws should be M3 threaded. Do not use spring washers.

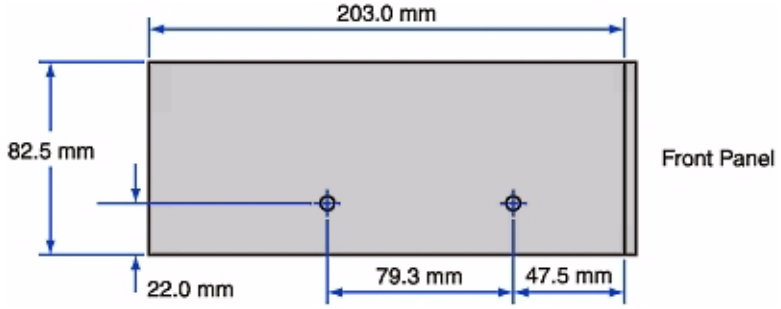
The recommended mounting torque is 6.0 ±0.5 in-lbs (60–70 N/cm).

HP recommends 0.3 mm mounting clearance around all covers for isolation mounting movement.

Bottom Panel, Full-Height Internal Drives



Side Panel, Full-Height Internal Drives

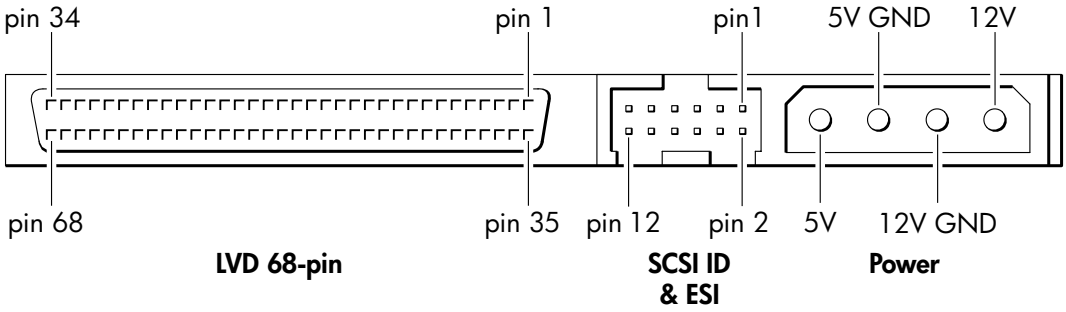


Connecting the Drive

SCSI Connector

For the location of the rear panel SCSI connectors, see page 101.

The SCSI drive uses a straddle-mounted three-part SCSI peripheral connector. This incorporates a 68-pin high density SCSI connector, a 4-pin power connector and a 12-pin auxiliary connector.

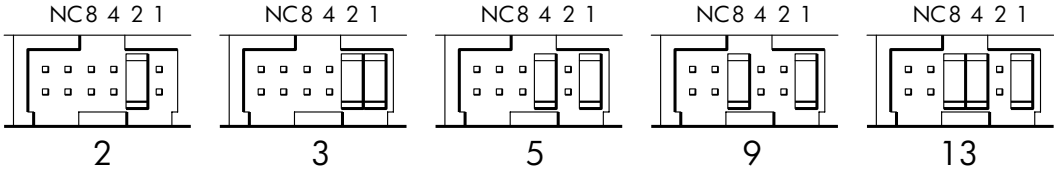


The auxiliary connector is used for setting the SCSI address and potentially as an Enhanced Serial Interface (ESI). The pins are as follows:

Pin	Signal	Description
1	SEL0-	SCSI ID 0 (active low)
2	GND	Ground
3	SEL1-	SCSI ID 1 (active low)
4	GND	Ground
5	SEL2-	SCSI ID 2 (active low)
6	GND	Ground

Pin	Signal	Description
7	SEL3-	SCSI ID 3 (active low)
8	GND	Ground
9	ESIS-	ESI active (active low)
10	ESI0-	ESI Pin 0 (active low)
11	ESI1-	ESI Pin 1 (active low)
12	3.3V	3.3V (supplied by drive)

The following diagram shows jumper settings for a few example SCSI IDs:



To connect an internal drive:

1. Attach a spare power cable from the computer's internal power supply to the power connector.
2. Attach a spare connector on the computer or HBA's SCSI ribbon cable to the SCSI connector of the drive.
3. If the drive is the last device on the SCSI chain, make sure that the SCSI cable is terminated correctly.

Termination

Termination must be present at two and **only** two positions on the SCSI bus—at the beginning of the SCSI bus and at the end of the SCSI bus. Termination is normally enabled by default on the HBA and most internal SCSI cables have a terminator attached. This will usually be a small, rectangular block of plastic attached to the cable end and marked 'SCSI Terminator'.

Therefore, assuming the HBA is the first device on the bus, you should check that the second terminator is placed after the last device. If the drive should be the only device on a bus, as is recommended, the terminator should be placed after the drive.

Termination Power

With HP's Ultrium drives, termination power is always provided; you cannot switch it off. The supply is a 5V line via a fuse and diode/capacitor combination. In this way, the drive "tops up" the termination power voltage if the host supply is below 5V (due to cable length or bad host termination power).

Backup Software

You need backup software that supports the HP Ultrium drive within your system's configuration. In a direct attach configuration, where the tape drive is attached to a standalone server, you can use backup software that is designed for a single server environment. In network and SAN configurations, you will need backup software that supports enterprise environments. As a general rule, native backup applications (such as NTBackup and tar) do not provide the required data streaming rate to get the full performance of your drive. For the latest list of backup packages that support HP Ultrium drives, please consult our World Wide Web site (www.hp.com/go/connect).

Applications usually recognize tape drives by their manufacturers' ID string rather than their model number, so check the table below for the appropriate reference.

Drive Model	ID String
Generation 2 Ultrium drive	`HP Ultrium 2-SCSI`

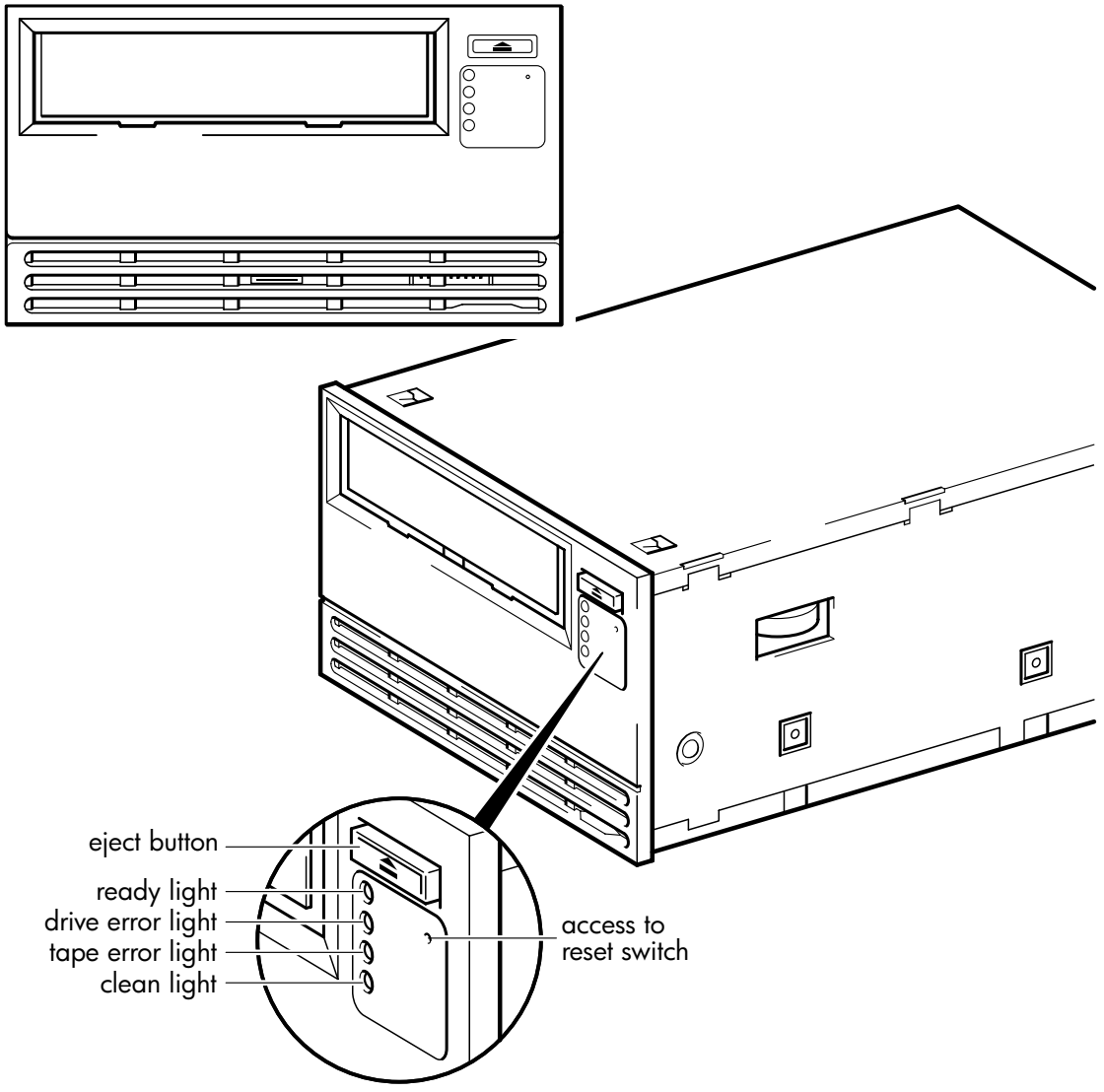
Operating the Drive

Internal drives are powered on when you switch on your computer.

The tape drive will run its hardware self-test, which takes about 5 seconds. During the test the 'Ready' LED flashes and all the other LEDs are off. On successful completion the 'Ready' LED is on. If the self-test fails, the 'Drive Error' and 'Tape Error' LEDs flash, while the 'Ready' and 'Clean' LEDs are off. This continues until the drive is reset.

- If you have just installed the drive, check the installation for loose connections, reset the drive and repeat the self-test.
- Try the "Troubleshooting" on page 78 to determine what the problem is.
- If the fault condition persists, call for assistance.

Front Panel Features



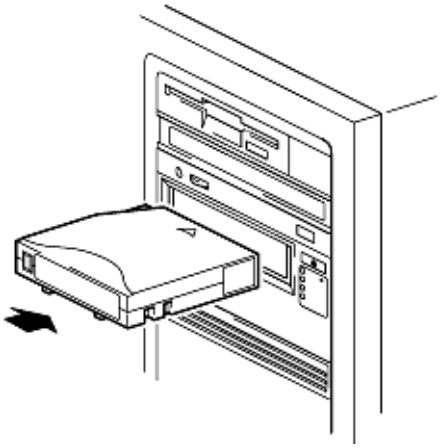
LEDs

For details of the front panel LEDs, see page 93.

Reset Switch

The emergency reset switch allows you to reset the drive without powering off the drive and computer, for example if the drive stops responding. Access to the switch is through a small hole. It can be activated by a thin object, such as the end of a straightened paper-clip.

Loading a Cartridge



Use HP Ultrium cartridges with your drive.

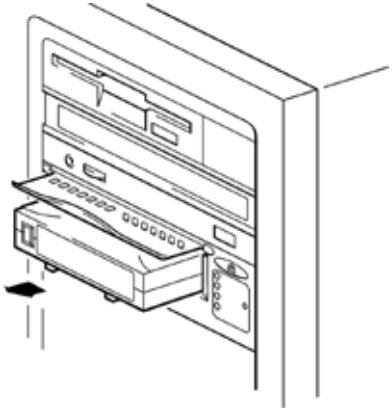
1 Insert the cartridge into the slot in front of the drive with the white arrow uppermost and facing the drive door.

2 Apply gentle pressure on the rear of the cartridge until the drive takes the cartridge and loads it.

The Ready LED flashes green while the drive performs its load sequence. When the cartridge is loaded, the Ready LED shows steady green.

Do not try to force the cartridge if it does not load properly. The drive will eject the cartridge after about 10 seconds so you can load it again.

Unloading a Cartridge



1 Press the Eject button on the front panel.
During the unload sequence the READY LED flashes green. The drive completes any task it is currently performing, winds the tape to the beginning and ejects the cartridge. Once the tape has rewound, the eject cycle will take less than 13 seconds.

2 Remove the cartridge and store it in its plastic case in a cool, dry atmosphere.

Cleaning the Drive

Caution It is essential to use only Ultrium cleaning cartridges with HP Ultrium tape drives as other format cleaning cartridges will not load and run. Use of HP cleaning media will ensure your tape drive is fully protected.
Do not use swabs or other means of cleaning the heads.

When the drive needs cleaning, the orange 'Clean' LED on the tape drive will flash. Only insert a cleaning cartridge into the tape drive when the LED flashes.

The drive's TapeAlert feature will send a message to your backup application when the tape heads need cleaning or a cleaning cartridge has expired.

A cleaning cartridge can be used up to 50 times.

To clean the heads, proceed as follows:

1. Insert a cleaning cartridge into the drive. The tape drive automatically loads the cartridge and cleans the heads.

   If the cleaning cartridge ejects immediately, it has expired or it is not an Ultrium cleaning cartridge (or is an older Ultrium Generation 1 cleaning cartridge manufactured by a vendor other than HP). In this case, discard the cleaning cartridge and repeat the operation with a new one.

   The cleaning cycle can take up to 5 minutes. During it the orange 'Clean' LED will be on and the green 'Ready' LED will flash. When it has finished, the drive ejects the cartridge.

2. Remove the cleaning cartridge from the drive.

Troubleshooting

Emergency Unload

If a cartridge fails to eject using the normal unload procedure, press and hold the Eject button for 10 seconds. This will instruct the drive mechanics to perform an emergency unload. Wait for the cartridge to be ejected. This process may take up to 15 minutes (the maximum rewind time).

If the cartridge is still jammed, press the emergency reset button (see page 77). Wait for the drive to reset and get back to the loaded position. This process may take up to 15 minutes (the maximum rewind time). Press and hold the Eject button for 10 seconds to perform an emergency unload on the reset drive.

General Guidelines

If you experience problems when using the tape drive, you need to isolate the cause of the problem. For example, if you have just installed a new SCSI host bus adapter and your system will not start, the cause of the problem is likely to be the adapter.

When installing multiple items of hardware and software, we recommend that you install each in turn and restart the system each time. Similarly if you have already installed multiple devices and software and you experience problems, remove or uninstall each in turn to establish which one is causing the problem.

Remember that the system recognizes devices during boot-up. If you swap or connect a product when your system is running, you will need to reboot the system. Rebooting the system will reset devices and will often resolve problems. It is good practice to reboot every time you add a driver or install firmware.

Diagnosing the Problem

The first step in problem-solving is establishing whether the problem lies with the cartridge, the drive, the host computer and its connections, or with the way the system is being operated.

Problems with the Host Computer

Most modern SCSI host bus adapters locate and display attached devices when the system is booting up. If the device is not detected at this stage, there is probably a problem with the physical hardware: cables, termination, connections, power or the HBA itself. Refer to the page 72 for a detailed discussion of SCSI IDs, termination and cabling.

If your drive is found on system boot up but cannot be found in the operating system, this is more likely to be a software problem.

Computer does not boot up

Possible Cause	Potential Solution
You have connected the tape drive to an existing SCSI bus that has other devices connected to it and the SCSI address of the drive is identical to the address used by another device.	Make sure that each device on the SCSI bus has a unique ID. We recommend that the tape drive is connected to a dedicated host bus adapter. Do not connect the drive to a disk RAID controller as this is not supported.
You have installed an additional SCSI host bus adapter and its resources are clashing with an existing adapter.	Remove the new host bus adapter and check the server documentation.
You have disconnected the power or SCSI cable from the computer's boot disk during the drive installation process.	Check that the cables to all devices are firmly connected.

Computer boots, but does not recognize the drive

Possible Cause	Potential Solution
The power or SCSI cable is not connected properly.	Check that the cables to the tape drive are firmly connected. Ensure that the SCSI cable is LVDS-compliant and that it does not have any bent pins. Replace, if necessary.
The SCSI bus is not terminated correctly.	Remove the new host bus adapter and check the server documentation.
The tape drive's SCSI ID address is not unique.	Make sure that each device connected to the SCSI controller has a unique SCSI ID. Remember that 7 is normally reserved for the host bus adapter.

Problems with the Drive and Cartridge

Tape drive does not power up

Possible Cause	Potential Solution
The power cable is not connected properly.	■ Check that the cables to the tape drive are firmly connected. ■ Make sure that the power cable is firmly connected. ■ Try another power connector. ■ If the power supply is present and all LEDs remain off, call support

Possible Cause	Potential Solution
The self-test fails (Ready LED is off and the other LEDs are on steadily).	If there is a cartridge in the drive, remove it. Power down the drive and power it up again. If the self-test still fails, call support.

The application does not recognize the drive

Possible Cause	Potential Solution
The application does not support the tape drive.	Check that the drive is installed properly. Refer to our World Wide Web site (www.hp.com/go/connect) for details of backup applications that support HP Ultrium tape drives. Load any service packs as necessary.
Some applications require drivers to be loaded.	Check that the correct SCSI and tape drive drivers are installed. Consult the backup application's installation notes for details.

The cartridge will not eject

Possible Cause	Potential Solution
The cartridge is jammed in the drive, or the backup application cannot eject the cartridge. This is most likely to be a communication problem between the drive and the system.	Check there is power to the drive. Press and hold the Eject button for 10 seconds. Allow the drive up to 15 minutes to eject (this is the maximum rewind time of the cartridge.) If the cartridge is still jammed, reset the drive (see page 77). Allow 15 minutes for the drive to return to the loaded position. Press and hold the Eject button for 10 seconds to eject the cartridge from the reset drive. If the cartridge is still jammed, call for support.

The drive will not accept a cartridge

Possible Cause	Potential Solution
The cartridge is not compatible with your tape drive.	Check that you are using the correct media. DLT cartridges are not compatible with Ultrium drives. Check the orientation of the cartridge when loading into the drive.

Possible Cause	Potential Solution
The cartridge has been damaged.	Check that the cartridge case is not cracked or split. Check that the leader pin is not damaged. If damage is found, discard the cartridge. Check that the cartridge teeth are not damaged. If damage is found, discard the cartridge. If the drive will still not accept the cartridge, try using a new or known good cartridge. If it loads, the original cartridge is faulty and should be discarded. If the original cartridge is accepted in another tape drive, the original tape drive may be at fault. Check the SCSI connection and that the tape drive is recognized by the backup application.
The tape drive is faulty.	Check that the drive is powered on. If the drive still will not accept the cartridge, there may be a problem with the drive's cartridge memory. Call for support.

External Standalone Drives

5

For the physical specification of the drive, see Chapter 1, "Physical Specification" in **Specifications**, Volume 4 of the Ultrium Technical Reference Manual.

If you are installing the tape drive on a UNIX system, refer to the **UNIX Configuration Guide**, Volume 6 of the Ultrium Technical Reference Manual.

Identifying the Drive

The model name is on the front panel and the product and serial numbers are on a label on the bottom of the drive.

Connecting the Drive

For details of the rear panel connectors, see Chapter 7 on page 99.

SCSI Connection

The cable provided will attach to a computer with a 68-pin very high density SCSI-3 connector. We do not recommend connecting the drive to an Ultra2, SE SCSI connector or a narrow SCSI host bus adapter. To benefit from the advantages of LVD SCSI, it is important always to use LVDS-rated SCSI cabling. If the server or host bus adapter is equipped with a high density (HD) wide SCSI connector, you will need to use an adapter or HD-to-HD cable.

Termination

Both ends of a SCSI bus must be terminated. As long as the drive is the last or only device on the SCSI bus, the drive enclosure automatically provides active termination when a cable is connected to the SCSI-IN connector. If there are

other devices on the bus (which is not recommended), use the SCSI-OUT connector to connect to the next device in the chain, and make sure that the chain is terminated at the end with a multimode terminator.

If the drive is providing active termination, the green LED on the rear panel marked Act TERM will be lit (see page 101).

Termination Power

With HP's Ultrium drives, termination power is always provided; you cannot switch it off. The supply is a 5V line via a fuse and diode/capacitor combination. In this way, the drive "tops up" the termination power voltage if the host supply is below 5V (due to cable length or bad host termination power).

Moving Drives

If there is a tape in the drive, unload it before powering down and moving the drive. When the drive is powered down, there is no physical lock on the tape reels. If you leave a tape threaded in the drive with the power off, the reels could rotate, causing a loop of tape to occur in the tape path. When the drive is next powered up, the tape could then fall off the guides and be damaged.

If for any reason you must move a drive with a tape threaded, move it slowly and carefully, making no sudden movements that could cause the reels to rotate.

Operating the Drive

Switch on external drives using the power switch on the front panel, and then switch on the computer.

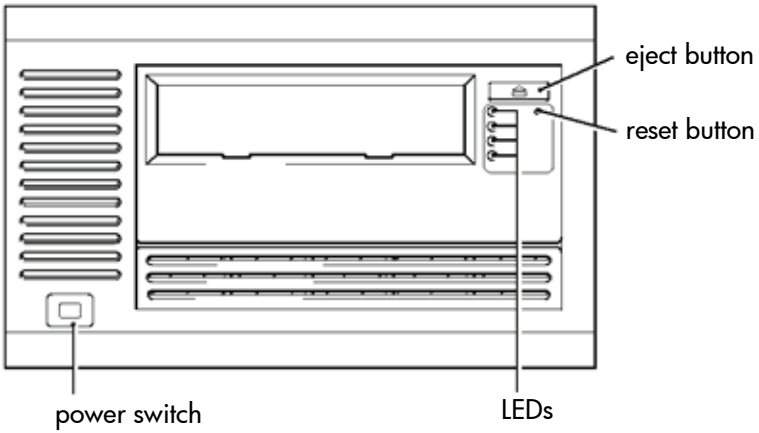
The tape drive will run its hardware self-test, which takes about 5 seconds. During the test the 'Ready' LED flashes and all the other LEDs are off. On successful completion the 'Ready' LED is on.

If the self-test fails, the 'Drive Error' and 'Tape Error' LEDs flash, while the 'Ready' and 'Clean' LEDs are off. This continues until the drive is reset.

- If you have just installed the drive, check the installation for loose connections, reset the drive and repeat the self-test.

- Try "Troubleshooting" on page 88 to determine what the problem is.
- If the fault condition persists, call for assistance.

Front Panel Features



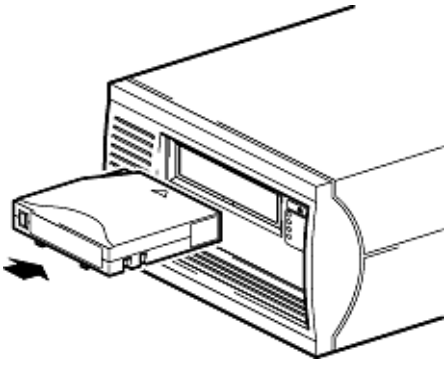
LEDs

For details of the front panel LEDs, see page 93.

Reset Switch

The emergency reset switch allows you to reset the drive without powering off the drive and computer, for example if the drive stops responding. Access to the switch is through a small hole. It can be activated by a thin object, such as the end of a straightened paper-clip.

Loading a Cartridge



Use HP Ultrium cartridges.

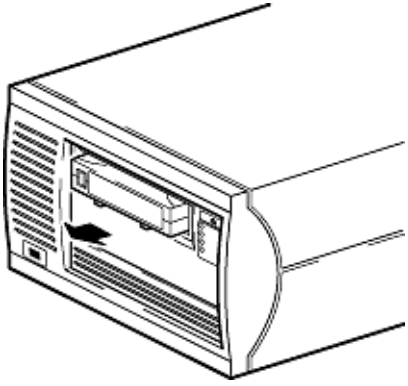
1 Insert the cartridge into the slot in front of the drive with the white arrow uppermost and facing the drive door.

2 Apply gentle pressure on the rear of the cartridge until the drive takes the cartridge and loads it.

The Ready LED flashes green while the drive performs its load sequence. When the cartridge is loaded, the Ready LED shows steady green.

Do not try to force the cartridge if it does not load properly. The drive will eject the cartridge after about 10 seconds so you can load it again.

Unloading a Cartridge

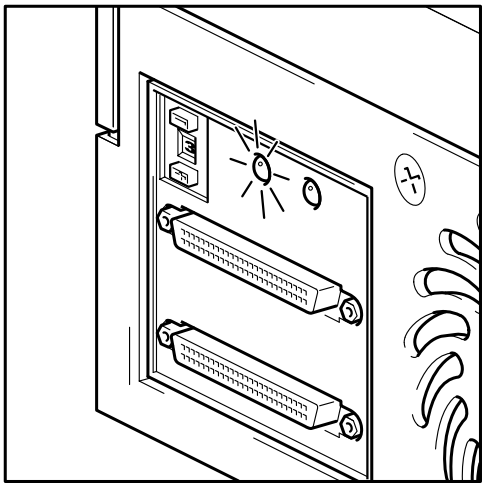


1 Press the Eject button on the front panel.
During the unload sequence the READY LED flashes green. The drive completes any task it is currently performing, winds the tape to the beginning and ejects the cartridge. Once the tape has rewound, the eject cycle will take less than 13 seconds.

2 Remove the cartridge and store it in its plastic case in a cool, dry atmosphere.

Rear Panel LEDs

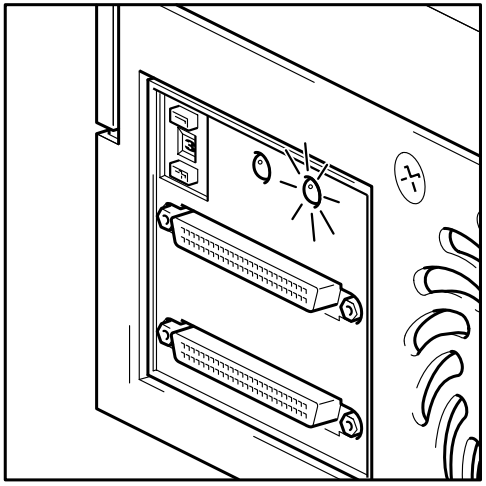
The rear panel has two additional LEDs as shown below.



Act TERM (termination active)

Off The drive enclosure is not providing active termination (there is another device or terminator attached to the SCSI-OUT connector).

On The drive enclosure is providing active termination on the SCSI bus.



Fan/PWR Fault (fault with the fan or power supply)

Off No fault has been detected.

On A fault has been detected with the fan or power supply. Call for support.

Cleaning the Drive

When the drive needs cleaning, the orange 'Clean' LED on the tape drive will flash. Only insert a cleaning cartridge into the tape drive when the LED flashes.

Note The drive's TapeAlert feature will send a message to your backup application when the tape heads need cleaning or a cleaning cartridge has expired.

Caution It is essential to use only Ultrium cleaning cartridges with HP Ultrium tape drives as other format cleaning cartridges will not load and run. Use of HP cleaning media will ensure your tape drive is fully protected.
Do not use swabs or other means of cleaning the heads.

A cleaning cartridge can be used up to 50 times.

To clean the heads:

1. Insert a cleaning cartridge into the drive. The tape drive automatically loads the cartridge and cleans the heads.

   If the cleaning cartridge ejects immediately, it has expired or it is not an Ultrium cleaning cartridge (or is an older Ultrium Generation 1 cleaning cartridge manufactured by a vendor other than HP). In this case, discard the cleaning cartridge and repeat the operation with a new one.

   The cleaning cycle can take up to 5 minutes. During it the orange 'Clean' LED will be on and the green 'Ready' LED will flash. When it has finished, the drive ejects the cartridge.

2. Remove the cleaning cartridge from the drive.

Troubleshooting

Emergency Unload

If a cartridge fails to eject using the normal unload procedure, press and hold the Eject button for 10 seconds. This will instruct the drive mechanics to perform an emergency unload. Wait for the cartridge to be ejected. This process may take up to 15 minutes (the maximum rewind time).

If the cartridge is still jammed, press the emergency reset button (see page 85). Wait for the drive to reset and get back to the loaded position. This process may take up to 15 minutes (the maximum rewind time). Press and hold the Eject button for 10 seconds to perform an emergency unload on the reset drive.

General Guidelines

If you experience problems when using the tape drive, you need to isolate the cause of the problem. For example, if you have just installed a new SCSI host bus adapter and your system will not start, the cause of the problem is likely to be the adapter.

When installing multiple items of hardware and software, we recommend that you install each in turn and restart the system each time. Similarly if you have already installed multiple devices and software and you experience problems, remove or uninstall each in turn to establish which one is causing the problem.

Remember that the system recognizes devices during boot-up. If you swap or connect a product when your system is running, you will need to reboot the system. Rebooting the system will reset devices and will often resolve problems. It is good practice to reboot every time you add a driver or install firmware.

Problems with the Host Computer

Most modern SCSI host bus adapters locate and display attached devices when the system is booting up. If the device is not detected at this stage, there is probably a problem with the physical hardware: cables, termination, connections, power or the HBA itself.

If your drive is found on system boot up but cannot be found in the operating system, this is more likely to be a software problem.

Computer does not boot up

Possible Cause	Potential Solution
You have connected the tape drive to an existing SCSI bus that has other devices connected to it and the SCSI address of the drive is identical to the address used by another device.	Make sure that each device on the SCSI bus has a unique ID. We recommend that the tape drive is connected to a dedicated host bus adapter. Do not connect the drive to a disk RAID controller as this is not supported.
You have installed an additional SCSI host bus adapter and its resources are clashing with an existing adapter.	Remove the new host bus adapter and check the server documentation.
You have disconnected the power or SCSI cable from the computer's boot disk during the drive installation process.	Check that the cables to all devices are firmly connected.

Computer boots, but does not recognize the drive

Possible Cause	Potential Solution
The power or SCSI cable is not connected properly.	Check that the cables to the tape drive are firmly connected. Ensure that the SCSI cable is LVDS-compliant and that it does not have any bent pins. Replace, if necessary.
The SCSI bus is not terminated correctly.	Remove the new host bus adapter and check the server documentation.
The tape drive's SCSI ID address is not unique.	Make sure that each device connected to the SCSI controller has a unique SCSI ID. Remember that 7 is normally reserved for the host bus adapter.
The tape drive may have been switched on after the computer was booted up. The computer checks for SCSI devices only at power-on.	Switch on the tape drive, then switch the computer off and then on again.

Problems with the Drive and Cartridge

Tape drive does not power up

Possible Cause	Potential Solution
The power cable is not connected properly.	■ Check that the cables to the tape drive are firmly connected. ■ Make sure that the power cable is firmly connected. ■ The power on/off switch incorporates a green LED. If this is not on, check the power cable connection and replace the cable if necessary. You can use the power cable from your monitor or another device to check that the connection is working. ■ If the power supply is present and all LEDs remain off, call support
The self-test fails (Ready LED is off and the other LEDs are on solidly).	If there is a cartridge in the drive, remove it. Power down the drive and power it up again. If the self-test still fails, call support.

The application does not recognize the drive

Possible Cause	Potential Solution
The application does not support the tape drive.	Check that the drive is installed properly. Refer to our World Wide Web site (www.hp.com/go/connect) for details of backup applications that support HP Ultrium tape drives. Load any service packs as necessary.
Some applications require drivers to be loaded.	Check that the correct SCSI and tape drive drivers are installed. Consult the backup application's installation notes for details.

The cartridge will not eject

Possible Cause	Potential Solution
The cartridge is jammed in the drive, or the backup application cannot eject the cartridge. This is most likely to be a communication problem between the drive and the system.	Check there is power to the drive. Press and hold the Eject button for 10 seconds. Allow the drive up to 15 minutes to eject (this is the maximum rewind time of the cartridge.) If the cartridge is still jammed, reset the drive (see page 85). Allow 15 minutes for the drive to return to the loaded position. Press and hold the Eject button for 10 seconds to eject the cartridge from the reset drive. If the cartridge is still jammed, call for support.

The drive will not accept a cartridge

Possible Cause	Potential Solution
The cartridge is not compatible with your tape drive.	Check that you are using the correct media. DLT cartridges are not compatible with Ultrium drives. Check the orientation of the cartridge when loading into the drive.

Possible Cause	Potential Solution
The cartridge has been damaged.	Check that the cartridge case is not cracked or split. Check that the leader pin is not damaged. If damage is found, discard the cartridge. Check that the cartridge teeth are not damaged. If damage is found, discard the cartridge. If the drive will still not accept the cartridge, try using a new or known good cartridge. If it loads, the original cartridge is faulty and should be discarded. If the original cartridge is accepted in another tape drive, the original tape drive may be at fault. Check the SCSI connection and that the tape drive is recognized by the backup application.
The tape drive is faulty.	Check that the drive is powered on. If the drive still will not accept the cartridge, there may be a problem with the drive's cartridge memory. Call support.

Rear Panel LED Patterns

The two LEDs on the rear panel can give information about problems with the following patterns:

LEDs	Cause	Action required
	*The Act Term LED is off.* The enclosure is not providing auto-termination.	Check that the drive's SCSI cable is connected to the SCSI-IN connector. Check whether a terminator or other SCSI cable is plugged into the SCSI-OUT connector. If a terminator is connected, remove it. If another SCSI cable is connected, make sure that the SCSI chain is terminated at the last device.
	*The Fan/PWR LED is orange.* There has been an enclosure failure or the cooling fan is not working correctly.	Call support.

For more information about the rear panel LEDs, see page 86.

Front Panel LEDs

6

Three front panels have been designed:

- The default panel—see page 76
- An automation panel for use when the drive is embedded in automation applications—see page 18
- A third front panel allows a drive to be used in 2U autoloaders where the front panel cannot exceed the drive form factor in height and width—see page 19

The drive is not designed to operate without a front panel (even in automation applications). The front panel was designed to meet Section 508 accessibility guidelines.

Full details of the default front panel are given in the Operation topic within the User's Guide.

Usual Meaning of the LEDs

There are four LEDs, Ready, Drive Error, Tape Error and Clean. They usually have the following meanings:

Ready The top LED is green and indicates power and activity:

- *Off* The drive power is off or there was a failure during self-test.
- *Lit steadily* The drive is powered on and ready for use but no activity is occurring.
- *Flashing* The drive is engaged in activity, such as responding to a Read, Write or Space command or performing a self-test.
- *Fast flash* The drive is downloading firmware.

Drive Error The second LED is orange and indicates a problem with the drive:

- *Off* No fault has been detected.

Flashing An unrecoverable hardware failure has occurred. A power cycle or successful tape load will turn the LED off, but the LED will start flashing again if the same operation is performed and the hardware fault is still present

Tape Error The third LED is orange and indicates a problem with the tape:

Off No fault has been detected.

Flashing The drive thinks the tape currently in the drive is faulty. The LED could flash for a number of reasons, but they all relate to the tape being in error in some way, such as unreadable cartridge memory or unsupported tape. Do not use the cartridge; replace it. The LED will go out when a tape load is started.

Clean The bottom LED is orange and indicates if the drive needs cleaning.

Off The drive does not require cleaning.

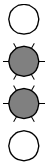
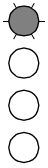
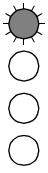
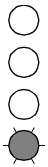
Lit steadily A cleaning cartridge is being used. the Ready LED will flash.

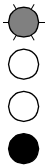
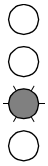
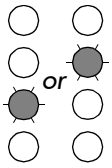
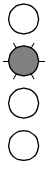
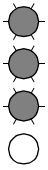
Flashing The drive needs cleaning. The LED will continue to flash if the drive is power cycled, and will only go out after a supported cleaning tape has been used.

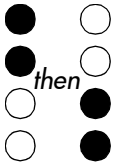
Other LED Patterns

There are other patterns usually involving several LEDs, which have the following meanings:

LED Sequence	Cause	Action required
◯ ◯ ◯ ◯	*All LEDs OFF.* Drive may not have power or may be faulty. This pattern occurs just after the drive has been switched on or reset.	Make sure the drive is switched on. The power on/off switch incorporates a green LED. If this is not on, check the power cable connection and replace the cable if necessary. You can use the power cable from your monitor or another device to check that the connection is working. If the power supply is present and all LEDs remain off, press emergency reset or power cycle the drive. If it still fails, call for service.

LED Sequence	Cause	Action required
	*Ready and* Clean *OFF. Drive Error and Tape Error FLASHING.* The drive has failed to execute power-on self test (POST).	Power cycle or reset the drive. If the error condition reappears, call for service.
	*Ready is ON.* The drive is ready for operation.	None. This is normal.
	*Ready is FLASHING.* The drive is carrying out a normal activity (read, write).	None. If the drive is upgrading firmware, do not reset or power cycle it.
	*Ready is FLASHING fast.* The drive is downloading firmware.	None. Do not reset or power cycle the drive.
	*Ready is OFF, others are ON.* Firmware is being reprogrammed.	None. Do not reset or power cycle the drive.
	Clean *is FLASHING.* The drive requires cleaning.	Load the Ultrium cleaning cartridge. See page 45 for supported cartridges and instructions. If the clean LED is still flashing when you load a new or known data cartridge after cleaning, call for service.

LED Sequence	Cause	Action required
	*Ready is FLASHING and* Clean *is ON.* Cleaning is in progress.	None. The cleaning cartridge will eject on completion. The cleaning cycle can take up to 5 minutes to complete.
	*Tape Error is FLASHING.* The drive believes the current tape or the tape just ejected is faulty.	Unload the tape cartridge. Make sure that you are using the correct format cartridge; an Ultrium data cartridge or Ultrium Universal cleaning cartridge. (See page 45.) Reload the cartridge. If the 'Tape Error' LED still flashes or starts flashing during the next backup, load a new or known, good cartridge. If the 'Tape Error' LED is now off, discard the 'suspect' tape cartridge. If it is still on, call for service.
	*The tape is ejected immediately and Tape Error is FLASHING, or Drive Error FLASHES on unloading tape.* The tape cartridge memory (CM) may be faulty.	Write-protect the cartridge by sliding the red switch on the tape cartridge. The tape can be loaded and the data read. Once the data is recovered, the cartridge must be discarded.
	*Drive Error FLASHING.* The drive mechanism has detected an error.	Load a new cartridge. If the error persists, power cycle or reset the drive. If the 'Drive Error' LED remains on, call for service.
	*Drive Error, Tape Error and Ready FLASHING.* There is a firmware download problem.	Insert a cartridge to clear the LED sequence; the drive will continue using the old firmware. If the condition persists, call for service.

LED Sequence	Cause	Action required
	*Drive Error and Ready ON with Tape Error and* Clean *OFF. Sequence alternates repeatedly.* The drive has a firmware error.	Power cycle or reset the drive. If the sequence occurs again, upgrade the firmware to a newer version. If the condition persists, call for service.

During Firmware Upgrade

Caution Do not reset or power-cycle the drive until the firmware upgrade is complete, otherwise the drive will be not be able to operate.

If a firmware upgrade is successful, the pattern of LEDs during the download is as follows:

- The Ready LED flashes green while reading the firmware image.
- The lower three LEDs remains on steadily orange until the firmware upgrade is complete.
- The Ready LED flashes green and the tape is ejected.

If a corrupt or incompatible image is downloaded from tape for the firmware, the Ready LED will remain on steadily and the Tape Error LED will flash until a tape load is started. The other LEDs will be off.

Rear Panel and Connectors

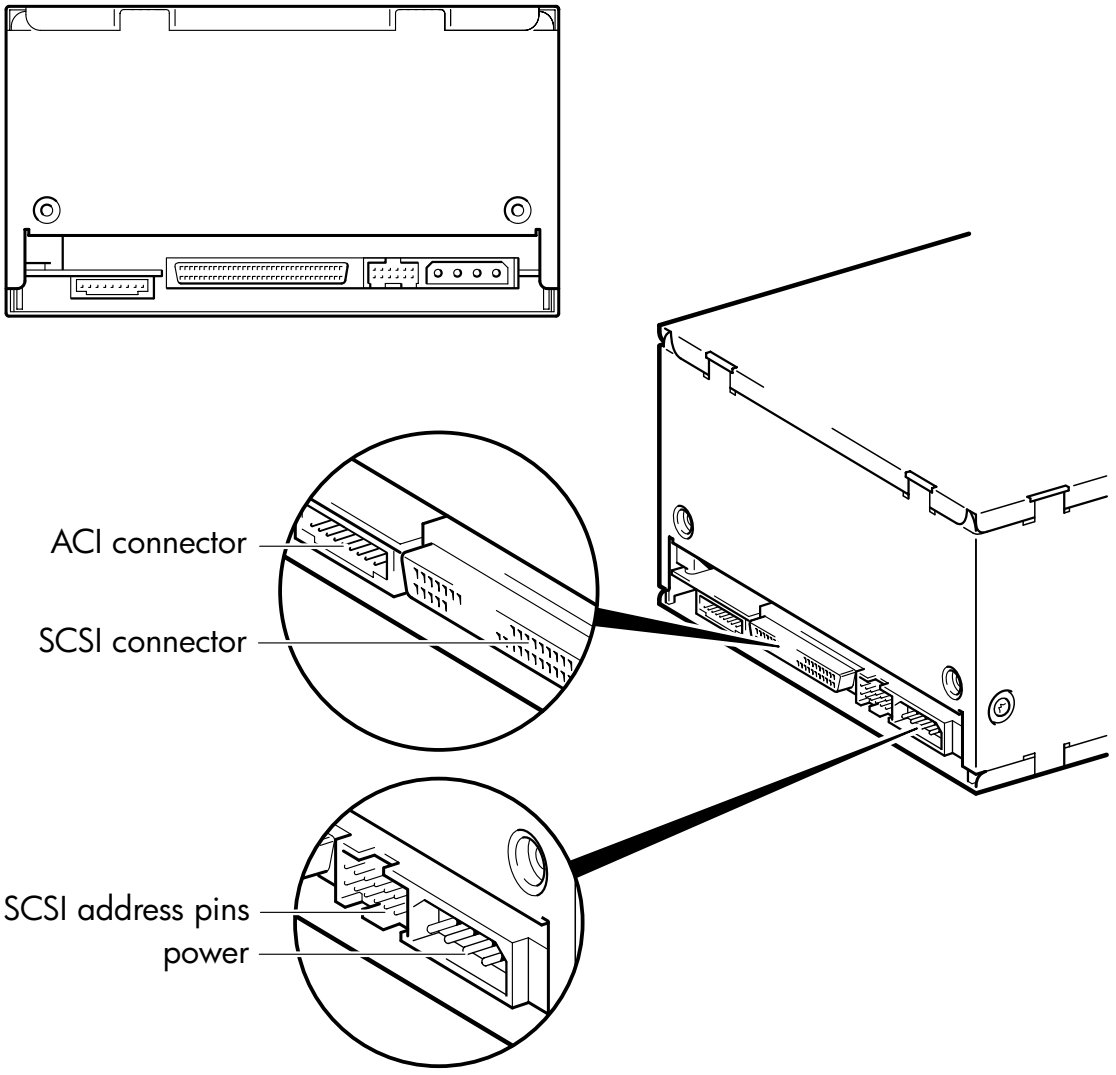
7

Rear Panel

The rear panel contains the connector interface that allows the tape drive to communicate with a tape library or host computer system. The panel includes the following connectors:

- A three-part SCSI connector
- ACI (for libraries)

Rear Panel Connectors for a SCSI Drive



Connectors

SCSI Connector

Ultrium drives are Ultra3 wide, SCAM-1 compliant SCSI devices designed to operate on a low voltage differential (LVD) SCSI bus. They use a 68-pin SCSI Ultra3 LVD interface to communicate with a tape library or host computer system.

The SCSI connection is a straddle-mounted three-part SCSI peripheral connector. This incorporates a 68-pin high density SCSI connector, a 4-pin power connector and a 12-pin auxiliary connector. The stub length (SCSI IC to connector) is 22 mm average.

In a library, the SCSI and power connectors interface with appropriate cables connected to the library bulkhead. The SCSI cables may be installed in a daisy-chain configuration linking two or more Ultrium tape drives within the library together on the same SCSI bus.

The auxiliary connector is used for setting the SCSI address.

Tape library suppliers set the SCSI jumpers to 3 before a tape drive is installed. This will be overridden by the tape library. Each device on the SCSI bus must have a unique SCSI ID set by the library.

Automation Control Interface (ACI) Connector

The automation connector is a 9-pin JST PH surface-mount right-angle connector (JST P/N S 9B-PH-SM3-TB). This is mounted alongside the SCSI connector. It can be mated with either crimped or insulation displacement connectors, as follows:

Crimped Connectors

housing: PHR-9

contacts: SPH-002T-P0.5S (for AWG# 30-24 wire)
SPH-004T-P0.5S (for AWG# 32-28 wire)

See http://www.jst-mfg.com/ProductGuideE/EPH.html for full details.

Insulation Displacement Connectors

- 09KR-8M for AWG# 28 wire

- 09KR-6S for AWG# 26 wire

See http://www.jst-mfg.com/ProductGuideE/EKR.html for full details.

Connector Pins

The pins of the ACI connector are as follows:

Pin	ID	Function
1	ACI_RX+	RS-422 Receive (+ side of the differential RS-422 line)
2	ACI_RX-	RS-422 Receive (- side of the differential RS-422 line)
3	GND	Ground
4	ACI_TX-	RS-422 Transmit (- side of the differential RS-422 line)
5	ACI_TX+	RS-422 Transmit (+ side of the differential RS-422 line)
6	ACI_DRV_SEN_L	Drive Sense. It is tied low in the drive so that a library can sense the presence of the drive. The library should have a pull-up resistor on this line. *Low:* Drive present *High:* Drive not present (3.3 or 5 volts)
7	ACI_LIB_SEN_L	Library Sense. The drive will not appear on SCSI or Fibre Channel until commanded when low. The line is pulled up to 5V in the tape drive. The automation controller should pull this pin low. *Low:* Drive is connected to an automation controller *High:* Drive is standalone (3.3 or 5 volts)
8	ACI_RST_L	Tape drive reset. The line is pulled up to 5V in the drive. The drive will perform a Drive Reset when this line is pulled low.
9	ACI_ATN_L	The drive sets this pin low to indicate to the automation controller that certain configured conditions have arisen, such as a SCSI Surrogate CDB.

For details of ACI commands, see Chapter 5 “Supporting Ultrium Features” of the **Software Integration Guide**, Volume 2 of the HP Ultrium Technical Reference Manual.

Modes of Usage and Optimizing Performance

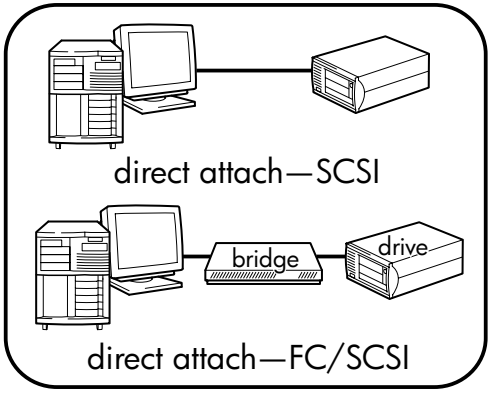
8

Modes of Usage

HP Ultrium tape drives and arrays can be used in different system configurations; they can be directly attached to a VHD SCSI connector on a server or fibre channel router. They can be used in a standalone (direct attach) or network environments (both Local Area Network and Storage Area Network).

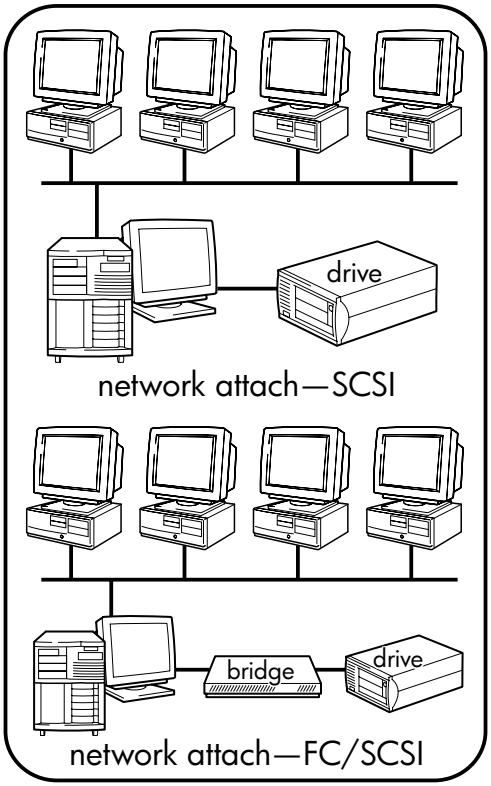
To connect to fibre channel you must purchase and install a supported fibre channel/SCSI router.

The tape drive or array should be connected to the VHD SCSI connector on the server or router. Network users may need to take additional steps/to ensure that their system is configured for optimum performance. These are described in "Optimizing Performance" on page 105.



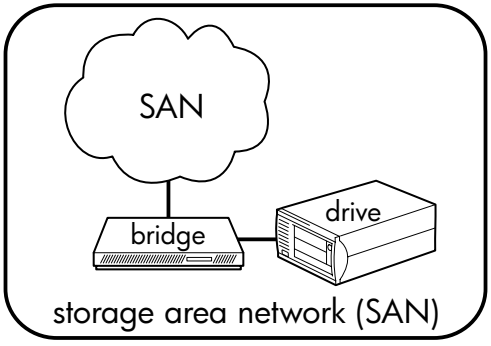
Direct Attach

The tape array is directly attached to a single server via a SCSI link or a fibre channel/SCSI router.



Network Attach (LAN)

The tape array is directly attached to a network storage server that can be accessed by a number of clients or workstations. As with the direct attach model, the connection is via a SCSI link or fibre channel/SCSI router to the storage server.



Storage Area Network (SAN)

The tape array is attached to the SAN via a fibre channel/SCSI router. The array can be used to back up any device in the fibre channel fabric; in practise, the system administrator decides which devices will be able to see and access the array.

Optimizing Performance

Various factors can affect tape drive performance, particularly in a network environment or if the drive is not on a dedicated SCSI bus. If your tape drive is not performing as well as expected, consider the following points before contacting HP Support at `www.hp.com/support`.

Dedicated SCSI Bus

For optimum performance, we recommend that the tape drive is the only device on the SCSI bus. If it is not, ensure other devices are LVD-compliant. If they are single-ended, the bus will switch to single-ended mode with a lower transfer speed. There will also be restrictions on cable length.

System Performance

Drives can write data at 30 MB/s (native) or 60 MB/s (2:1 compression). However, to get this performance it is essential that your whole system can deliver this performance.

Typical areas where bottlenecks can occur are:

- Disk system (a single hard disk drive will not be able to deliver 60 MB/s transfer rates).
- Some file systems are able to transfer data faster than others.
- The type of data being backed up can affect backup performance (for example, file sizes and compressibility).
- Some backup software performs better than others.

To improve performance you may like to consider a RAIDed disk solution with a large number of physical hard disks.

Some enterprise class backup applications can be made to interleave data from multiple sources, such as clients or disks, to keep the tape drive working at optimum performance.

Data Transfer Rate

Adaptive Tape Speed (ATS) enables the drive to “stream” data at variable tape speed, which means that it maintains a continuous data flow to tape even when the transfer speed varies. This is automatically managed by the

drive to keep the drive running at best performance. When using Ultrium 2 cartridges, the ATS range is 10–30 MB/s, so, if possible data transfer should remain within this range. In most cases, the backup application will provide details of the average time taken at the end of the backup.

Note For optimum performance always use Ultrium 2 400 GB cartridges. If you are using Ultrium 1 200 GB cartridges, the ATS range is 6.6-20 MB/s.

Performance Checklist

The following list summarizes factors that can affect performance. They provide guideline only of areas that may need further investigation. They do not attempt to explain how to configure individual systems. For a more detailed discussion, including information about tools that allow you to test performance, refer to our white papers on `www.hp.com`. (Select the product first and look at the Information Library.)

- Is the tape drive reading and writing data at the correct speed?
- Is the source system (hard disk) transferring data at the correct speed?
- Is the backup application writing buffers at the correct speed? You may need to tune the transfer, buffer and block size settings to optimize the speed that the application writes data to the tape drive. HP Ultrium drives have an internal buffer of 64 MB.
- Is the operating system tuned for performance? You may need to adjust the data transfer packet size.
- If you are in a SAN environment, are you are using one of the recommended fibre channel/SCSI routers?
- Are user applications, such as Exchange or database servers, optimized for backup performance?
- Are there other factors that could be affecting performance, such as interference or fibre channel infrastructure?

Cartridges

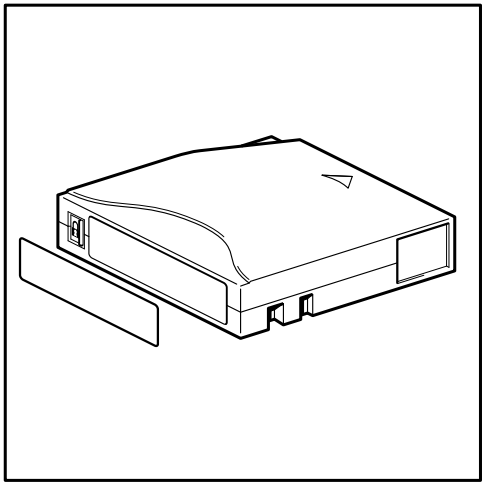
9

Choosing Cartridges

We recommend HP Ultrium 400 GB (2:1 compression) cartridges.

HP Ultrium drives will also support other lower capacity HP and non-HP Ultrium cartridges but the performance of your drive may be restricted. Data transfer rates will be slower on Ultrium Generation 1 200 GB cartridges compared to Ultrium Generation 2 400 GB cartridges. Do **not** use HP DLTIIItape or DLTIVtape cartridges. The size and shape of Ultrium media is very similar to that of DLT cartridges in order to make it easy for automation/library vendors to integrate Ultrium into existing DLT libraries. Compatible media can be recognized by the Ultrium logo, which is the same as the logo on the front of your drive.

Labeling Cartridges



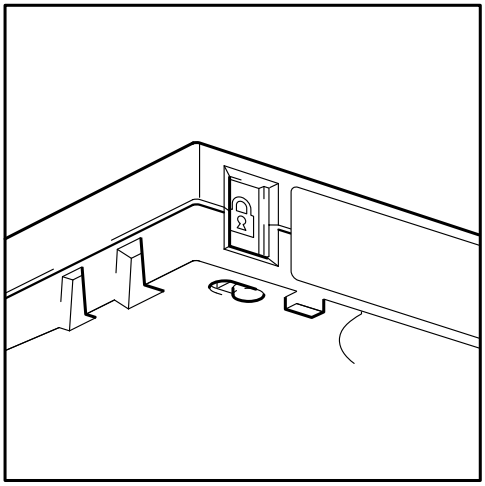
The label and write-protect switch are on the rear face of the cartridge, as illustrated.

Never use non-standard labels, and never stick anything to the cartridge other than in the label area.

Write-Protecting Cartridges

If you want to protect the data on a cartridge from being altered or overwritten, you can write-protect the cartridge. Do this before you insert the cartridge. If you slide the red tab after the cartridge is inserted in the drive, the change will not take effect until the cartridge is removed and reinserted.

Caution Write-protection will not prevent a cartridge being erased by bulk-erasure or degaussing. Do not bulk erase Ultrium format cartridges. This will destroy pre-recorded servo information and render the cartridge unusable.



To write-protect a cartridge, slide the red tab by the label area on the rear face of the cartridge to close the hole.

Note the padlock on the tab that indicates that the cartridge is protected.

To write-enable a cartridge, slide the red tab back so that the hole is open, before loading the cartridge into the drive.

Cartridge Life

Under optimum environmental conditions, HP Ultrium cartridges are currently specified to 1,000,000 passes over any part of the tape. In operational terms, this can be translated to about 2000 full backup or restore operations. However, it is recommended that cartridges are used for no more than 100 full backup operations and the cartridge warranty is based on this figure. Under severe environmental conditions, particularly where the tape drive is used at very low humidity or if certain areas of the tape are accessed frequently, the number of backup operations should be limited even further.

Caring for Cartridges

Avoiding Condensation

Condensation can be a problem for tape drives and cartridges. To minimize the chance of condensation, stay within the specifications for using and storing cartridges above and observe the following guidelines:

- Position the drive where the temperature is relatively stable—away from open windows, heat sources and doors.
- Avoid leaving cartridges in severe temperature conditions, for example, in a car standing in bright sunlight.
- Avoid transferring data (reading from and writing to cartridges) when the temperature is changing by more than 10°C (18°F) per hour.
- If you bring a cold tape drive or tape cartridge into a warm room, allow time for it to warm to room temperature before using it. For example, if you have moved the drive from a cold car to a warm room, allow time for the drive to reach room temperature (up to 24 hours if the temperature change is extreme).

Conditions in Use

Only use Ultrium cartridges in temperatures in the tape drive's operating range from 10°C to 40°C (50°F to 104°F) and 20 to 80% relative humidity (non-condensing). If you expose cartridges to temperatures outside the operating limits, stabilize them before you use them. To do this, leave the cartridges in the operating environment for 24 hours.

Conditions in Storage

Ultrium cartridges will preserve the integrity of stored data for at least 30 years if proper storage conditions are observed.

- Store cartridges at temperatures between 16°C and 32°C (61°F and 90°F) with a relative humidity between 20% and 80%.
- Always keep the cartridges in a clean environment.
- Always store cartridges in their plastic cases when not in use.

Maximizing Tape Life

- Do not touch the tape surface.
- Do not attempt to clean the tape path or tape guides inside the cartridge.
- Do not leave cartridge tapes in excessively dry or humid conditions.
- Do not leave cartridges in direct sunlight or in places where magnetic fields are present (for example, under telephones, next to monitors or near transformers).
- Do not drop cartridges or handle them roughly.
- Stick labels onto the label area only.

LTO Cartridge Memory

Linear Tape Open—Cartridge Memory (LTO-CM) is EEPROM memory that is embedded in every Ultrium tape cartridge. It is non-volatile and is contactless in that it is read by inductive coupling rather than electrical contact.

The Cartridge Memory is used to store the tape directory and diagnostic and log information. Because of the speed at which it can be read, load and unload times are reduced, information is found on the tape more quickly and fewer tape passes are needed, increasing tape reliability.

The memory is primarily designed to speed up internal operations in the drive, but it also contains free space that can be used by application software. Of the 4 kilobyte memory, about 1 kilobyte is free space. This may be used to store "common" information (shared by all software vendors) and "vendor-unique" information (specific to the application).

A SCSI access method has been defined to allow hosts to use this free space using Write Attribute and Read Attribute commands. For information on these commands, see Chapter 4 of **The SCSI Interface**, Volume 3 of this HP Ultrium Technical Reference Manual.

For details of use of LTO-CM in library applications, see "Using Cartridge Memory (LTO-CM)" on page 47.

For more information on LTO-CM, see "LTO Cartridge Memory" in Chapter 5 of **Background Information**, Volume 6 of this HP Ultrium Technical Reference Manual.

LTO Cartridge Memory Issues

The LTO Cartridge Memory stores identification and usage information such as the number of times the cartridge has been loaded, when it was last cleaned, and error logs. In the unlikely event of the Cartridge Memory becoming damaged, you may experience difficulty with the cartridge.

Use the following table to resolve LTO Cartridge Memory problems:

Problem	Cause	Solution
A new data cartridge that is write-enabled is rejected by the drive.	LTO Cartridge Memory has failed or is damaged.	Replace the data cartridge.
A new data cartridge that is write-protected is rejected in several known good drives.	LTO Cartridge Memory has failed and the drive has found no data to recover.	Replace the data cartridge.
A cartridge that has data written to it and is write-enabled is rejected by the drive.	LTO Cartridge Memory has failed or is damaged.	The data can still be recovered. Contact the tape library supplier for more information. After data recovery, replace the cartridge.
A cartridge that has data written to it and is write-protected restores very slowly.	LTO Cartridge Memory has failed and the drive cannot use the tape directory information to recover the data.	The data can still be recovered but may take longer than normal.

Drive Error Codes

10

The following error codes may be reported in bytes 16 and 17 of the Request Sense data. See the REQUEST SENSE command in Chapter 4 of the **SCSI Interface**, Volume 3 of the HP Ultrium Technical Reference Manual.

Generic Module (from 0000h)

Code	Description
0000h	Good
0001h	Bad
0003h	Aborted
0004h	Invalid configuration values
0005h	Invalid configuration name

Automation Control Interface (from 0400h)

Code	Description
0401h	Invalid command opcode
0402h	Busy—command rejected
0403h	RAMBIST failed
0404h	Invalid command checksums
0405h	Invalid baud rates
0406h	Invalid command while load/unload pending
0407h	Time-out waiting to end immediate command
0408h	RAM framing error
0409h	RAM overrun error
040Ah	Invalid command length
040Bh	Byte buffer framing error
040Ch	Byte buffer overrun error

Code	Description
040Dh	Command active abort rejected
040Eh	Invalid response acknowledgement
040Fh	Command packet timeout
0410h	Did not receive ETX
0411h	Cancel command packet timer error
0412h	Customer byte error
0413h	Response acknowledgement timeout
0414h	Cancel response acknowledgement timer error
0415h	Unexpected byte received
0416h	Zero length command
0417h	Invalid command reserved field
0418h	RAMBIST did not complete
0419h	Ignored a byte received while transmitting response
041Ah	Invalid command data length
041Bh	Firmware image too big
041Ch	The ACI response is longer than the available buffer.
041Dh	Did not receive acknowledgement to program flash
041Eh	Attempt to create a polling object instance without a polling function.
041Fh	Attempted to create more polling object instances than the maximum allowed.
0420h	Attempted to access a polling object instance that doesn't exist.
0421h	The ACI command length is greater than the available buffer.
0423h	The ACI has received a firmware image larger than expected.

Buffer Manager (from 0800h)

Code	Description
0800h	The buffer manager failed to initialize correctly.
0801h	No Buffer Allocation description exists for the supplied Module ID
0802h	The request queue has overflowed.
0803h	The priority request queue has overflowed.
0804h	Dataset index error: `BMMDataSetIdxToAddr()` has been passed an invalid `Idx`.

Code	Description
0805h	Dataset index error: `BMMDataSetIdxToDSITAddr()` has been passed an invalid `Idx`.
0806h	ACN index error: `BMMDataSetIdxToACNandLPOSAddr()` has been passed an invalid `Idx`.
0807h	Wrap index error: `BMMDataSetIdxToWrapAddr()` has been passed an invalid dataset `Idx`.
0808h	The Notification queue has overflowed. See `BMMXferComplete()`.

Diagnostic Control (from 1800h)

Code	Description
1800h	No errors
1801h	Invalid command
1802h	Invalid parameters
1803h	Drive not ready
1804h	Command failed
1805h	Command aborted
1806h	Too few parameters
1807h	Too many parameters
1808h	Command denied
1809h	CDB opcode error
180Ah	CDB page code error
180Bh	CDB buffer ID error
180Ch	Parity error on serial receive
180Dh	Framing error on serial receive
180Eh	Overflow error on serial receive
180Fh	Excessive input length, exceeding 220 characters
1810h	Power-on self-test not executed
1820h	Error detected during the Register Walking 1 test
1821h	Built-in self-test failure
1822h	No test available for the parameters provided
1823h	Error detected during the Memory test
1830h	Power-on self-test failed the main memory internal SRAM data bus test
1831h	Power-on self-test failed the main memory internal SRAM address bus test

Code	Description
1840h	Power-on self-test failed the DRAM MPU Port test
1841h	Power-on self-test failed the DRAM Data Bus test
1842h	Power-on self-test failed the DRAM Addr Bus test
1843h	Power-on self-test failed the Gen 1 Formatter ASIC Register test
1844h	Power-on self-test failed the Gen 1 Formatter ASIC built-in self-test)
1845h	Power-on self-test failed the Firmware Image Checksum
1846h	Power-on self-test failed the CRAM Data Bus test
1847h	Power-on self-test failed the CRAM Address Bus test
1848h	Power-on self-test failed the Generation 1 SCSI ASIC Register test
1849h	Power-on self-test failed the Generation 1 SCSI ASIC Buffer Data Bus test
184Ah	Power-on self-test failed the Generation 1 SCSI ASIC Buffer Address Bus test

Drive Control (from 1C00h)

Code	Description
1C00h	Bad cartridge type. Attempted to load a cartridge of a type that drive control cannot handle.
1C01h	Attempted to unload a cartridge when Prevent Medium Removal is on.
1C02h	There is no firmware image available for upgrade.
1C03h	Firmware image is incomplete.
1C04h	Firmware image has checksum or other errors.
1C05h	Firmware image is not compatible with the drive configuration.
1C06h	Firmware image is too big to upgrade from.
1C07h	Internal error in the Drive Control firmware upgrade code.
1C08h	A firmware upgrade cartridge was in the drive when it powered on.
1C09h	A load without threading has been requested for a cartridge with unusable Cartridge Memory.
1C0Ah	Tried to load a writable cartridge with an unusable Cartridge Memory.
1C0Bh	The write-protect tab setting was changed during a load.
1C0Ch	A non-HP cleaning cartridge has been inserted in the drive.
1C0Dh	Cannot determine the manufacturer of the cleaning cartridge.
1C0Eh	No DRAM space reserved to hold the firmware image.
1C0Fh	A cleaning cartridge was in the drive when it powered on.

Code	Description
1C10h	Drive Control did an eject during the power-on sequence.
1C11h	A firmware upgrade cartridge has been loaded when a data cartridge was expected.
1C12h	A firmware upgrade cartridge was expected but some other type of cartridge has been inserted.
1C13h	Failure due to drive temperature being out of acceptable range.

Drive Monitor (from 2000h)

Code	Description
2000h	No error. Synonymous with GOOD status.
2001h	Invalid parameter. The value of a parameter received with a Drive Monitor operation falls outside its valid range.

External Interfaces (from 2400h)

Code	Description
2400h	Command holder full
2401h	Bad command handle
2402h	Empty command handle
2403h	No tape loaded
2404h	Already loaded
2405h	In diagnostic mode
2406h	Not in diagnostic mode
2407h	Tried to write to write protected cartridge.
2408h	Aborted an active command.
2409h	Aborted a command before it became active.
240Ah	Tried to abort a command that was not queued.
240Bh	Invalid state requested of the EII State Manager.
240Ch	The EII tried to process a firmware upgrade type that is not supported.
240Dh	The EII state manager could not handle an abort request.
240Eh	Tried to abort a command that was already being aborted.

Front Panel Interface (from 2800h)

Code	Description
2801h	Failure due to use of forced eject

Host Interface (from 2C01)

Code	Description
2C01h	Unknown opcode
2C02h	Reserved field set
2C03h	Unknown mode page
2C04h	Firmware bug
2C05h	Parameter list length error
2C06h	Already prevented
2C07h	Not prevented
2C08h	Too many hosts
2C09h	32-bit overflow
2C0Ah	Invalid space code
2C0Bh	Bad inquiry page
2C0Ch	Not the reserver
2C0Dh	Not reserver
2C0Eh	Third-party bad
2C0Fh	Third-party host
2C10h	Reserved
2C11h	Read Buffer ID
2C12h	Read Buffer mode
2C13h	Write Buffer ID
2C14h	Write Buffer mode
2C15h	Main Buffer mode
2C16h	Write Buffer header
2C17h	No EVPD
2C18h	Drive not ready
2C19h	Density medium no tape
2C50h	Illegal SCSI command. The hardware or firmware does not recognize the CDB.

Code	Description
2C51h	The SCSI Macro command was aborted because the drive was selected first.
2C52h	ATN was pulled by the initiator.
2C53h	Initiator did not respond to reselect within the reselect timeout period.
2C54h	No port interface task. The internal port interface task queue was empty.
2C55h	Too many port interface tasks. There is no room left in the internal port interface task queue.
2C56h	Parity error on the SCSI bus
2C57h	Parity error in the mini-buffer
2C58h	Attempted to use an invalid value internally
2C59h	The SCSI FIFO was not empty when attempting to write to it.
2C5Ah	Not connected. Attempted to issue SCSI macro target command while not in target mode.
2C5Bh	Wrong host. Attempted to communicate with Host X while connected to Host Y.
2C5Ch	Wrong bus state. Attempted SCSI macro command while in the incorrect bus phase.
2C5Dh	No information on host. This host has not communicated with us previously.
2C5Eh	Invalid speed. The saved SCSI bus speed for this host is corrupt.
2C5Fh	Invalid SCSI ID, outside the range 0-15
2C60h	The group code in CDB is not supported.
2C61h	The host attempted to issue an overlapped command.
2C62h	Not enough buffer space. The internal requestor asked for more space than was available in the mini-buffer.
2C63h	The mini-buffer is non-functional.
2C64h	Buffer in use. The internal requestor was denied access to the mini-buffer
2C65h	Status interrupted; the SCSI status phase failed.
2C66h	Received an IDF (Initiator Detected Error) message
2C67h	Received an MPE (Message Parity Error) message
2C68h	Received a BDR (Bus Device Reset) message
2C69h	Received an Abort message
2C6Ah	Failed the Media Information check
2C6Bh	There is no tape in the drive.
2C6Ch	Loading a tape
2C6Dh	Media changed. A tape is present in the drive but not loaded.
2C6Eh	Cleaning the tape heads.

Code	Description
2C6Fh	Received a PON or SCSI reset
2C70h	A mode change (LVD/SE) occurred on the SCSI bus.
2C71h	Gross error detected by the SCSI Macro
2C72h	Illegal length record (ILI) — too long
2C73h	Illegal length record (ILI) — too short
2C74h	CRC error on read
2C75h	The requested burst size was larger than the drive supports.
2C76h	There was an invalid field in the mode parameter list for this MODE SELECT command
2C77h	Unloading the tape
2C78h	A parameter supplied by the internal requestor was out of range
2C79h	The allocation length exceeded the permitted length.
2C7Ah	Invalid (unsupported) page code
2C7Bh	Invalid (unsupported) page code in parameter list
2C7Ch	BOT encountered on space
2C7Dh	EOT encountered on space
2C7Eh	Blank Check, EOD was encountered. Returned by `hiPerformPreExeChecks` if a space or read is attempted on a virgin tape.
2C7Fh	Position lost. A temporary code for returning status after a write-behind error.
2C80h	PCR error in the LOG SELECT command
2C81h	The supplied Page Code is not a resetable page.
2C82h	The supplied Page Code is not a writable page.
2C83h	The reserved bit in the Log Page header has been set.
2C84h	The LOG SELECT Page Length is incorrect.
2C85h	There is an error with the Log Parameter Header.
2C86h	LOG SELECT Parameter list length error.
2C87h	The LOG SENSE Page Code is invalid.
2C88h	The LOG SENSE PC Code is in error.
2C89h	LOG SELECT: error in the parameter header
2C8Ah	Restart the Logical Pipeline after a format error
2C8Eh	The Buffer Manager has been interrupted with an error.
2C8Fh	Check the cables. The Host Interface has exhausted all of the retries for a data phase.
2C90h	LOG SELECT parameter list length error

Code	Description
2C91h	This error code will never be seen.
2C92h	The failure prediction threshold has been exceeded. This error code is sent when a CHECK CONDITION is generated for a CDB as a result of the Test flag being set in the Information Exceptions Mode page.
2C93h	Reset after GE. Triggers the power-on self-test UA 2900 after Generation 1 SCSI ASIC GE has been detected.
2C94h	Return GOOD status. Used to force GOOD status to be returned.
2C95h	There is a firmware bug in the handling of an INQUIRY page.
2C96h	There is a firmware bug in the execution of the **`Prevent/Allow Medium Removal`** command.
2C97h	There is a firmware bug in the parsing of a Mode page.
2C98h	An attempt was made to write data or filemarks inside EW-EOM.
2C99h	Firmware incorrectly programmed the SCSI macro.
2C9Ah	An unsupported LUN was specified in the SCSI Identify message.
2C9Bh	Aborting a previous command
2C9Ch	Aborting and no disconnect. A command was rejected that could not be queued while an abort was in progress.
2C9Dh	The host interface has exhausted all of the retries for a command phase.
2C9Eh	Parameter not supported. A request for an invalid page code has been sent.
2C9Fh	Buffer offset good. This is used internally by the Read Write Buffer code and should never be reported to the host.
2CA0h	Operation in progress. Reported when an Immediate command is executing and a subsequent command is received.
2CA1h	Illegal length record (ILI) — too long, and there is an EOR in FIFO. This occurs when a record is long by less than the FIFO length.
2CA2h	Illegal length record (ILI) — too short with bad CRC
2CA3h	Illegal length record (ILI) — too long with bad CRC
2CA4h	LUN not configured. The drive is the process of becoming ready.
2CA5h	ILI long has been detected but a read error was encountered during the residue flush.
2CA6h	An init command is required; a tape has been loaded but not threaded.
2CA7h	ILI long has been detected but flushing the residue timed out.
2CA8h	Generation 1 drives only: The CD-ROM El Torito identifier is corrupt.
2CA9h	The Gen 1 Formatter ASIC is not supported any more.
2CAAh	The Generation 1 SCSI ASIC is an invalid revision.

Code	Description
2CABh	MAM attribute header truncated. The specified parameter list length has caused an attribute header to be truncated.
2CACh	Reserved field set in a MAM attribute header
2CADh	MAM attribute IDs were not ascending order.
2CAEh	The MAM attribute header specified an unsupported attribute value.
2CAFh	A MAM attribute ID is unsupported.
2CB0h	A MAM attribute ID is in an incorrect format.
2CB1h	The MAM attribute header specifies an incorrect length for this attribute
2Cb2h	The host attribute area in MAM is full.
2CB3h	A WRITE ATTRIBUTE command attempted to delete a non-existent attribute.
2CB4h	An invalid MAM service action was requested.
2CB5h	A READ ATTRIBUTE command failed because the Host Attribute area was not valid.
2CB6h	There is an invalid field in the MAM attribute data.
2CB7h	Failure prediction threshold exceeded. A Tape Alert flag has been set and the next SCSI command needs to be check conditioned.
2CB8h	GWIF idle error, cause unknown. This will never be returned to the host.
2CB9h	GWIF idle, read error. This will never be returned to the host.
2CBAh	GWIF idle, write error. This will never be returned to the host.
2CBBh	MAM is accessible but the cartridge is in the load “hold” position. UNIT ATTENTION is generated.
2CBCh	MAM is accessible but the cartridge is in the load “hold” position. NOT READY is generated.

Logical Formatter (from 3000h)

Code	Description
3000h	No error. Synonymous with GOOD status.
3001h	Operation of the Logical Formatter has been aborted.
3002h	Busy. A Logical Formatter process has received a operation request while in a transient state.
3003h	Invalid parameter.
3004h	Unsupported operation. A Logical Formatter process received an operation request while in a mode that does not support that operation.
3010h	Power-on or reset failure

Code	Description
3011h	Unexpected interrupt. A Logical Formatter process received a signal from the hardware at an unexpected time.
3020h	Data path not empty. The Hardware Functional Blocks that form the Logical Formatter data path contain data.
3021h	Filemark encountered
3022h	Recoverable format error. The Logical Formatter has encountered a format error while unformatting the data stream.
3023h	Unrecoverable format error. The Logical Formatter has encountered a format error while unformatting the data stream.
3024h	End marker not required. The Logical Formatter has not inserted an end marker in the current dataset because the dataset is empty.
3025h	One or more Hardware Functional Blocks in the Logical Formatter are paused.
3026h	The Logical Formatter has a filemark pending, meaning that it is logically before the filemark but physically after it.
3027h	Restart the Logical Formatter hardware.
3028h	The Logical Formatter has provided a dataset with an access point beyond the target position.
3301h	Operation of the Logical Formatter's Hardware Abstraction Layer has been aborted.
3302h	Invalid parameter passed to a function in the Logical Formatter's Hardware Abstraction Layer.
3303h	A function in the Logical Formatter's Hardware Abstraction Layer has detected an illegal combination of variable values.
3304h	A function in the Logical Formatter's Hardware Abstraction Layer has received a request while in a mode that does not support that request.
33FFh	A non-specific error has occurred in the Logical Formatter.

Logical Media (from 3400h)

Code	Description
3400h	Cache overflow. A dataset has been received when the cache is already full.
3401h	Unexpected dataset. A dataset has been located in the cache where it should not be.
3402h	Unexpected tag. A tag dataset has been located in the cache where it should not be.
3403h	Attempted to unlock a dataset which is not locked
3404h	Cache empty. Expected at least one dataset in the cache.
3405h	The dataset index appears in the cache more than once.

Code	Description
3406h	The dataset index is too large to be valid.
3407h	The cache entry does not contain valid datasets.
3408h	End-Of-Data has been encountered.
3409h	The number of tag datasets in the cache exceeds the limit.
340Ah	A dataset is positioned in the cache incorrectly.
340Bh	One or more dataset indices are missing from the cache.
340Ch	Not a recognized Virtual Mode.
340Dh	The operation is not supported when more than one dataset locked.
340Eh	The tape is unformatted or contains no user datasets.
340Fh	One or more cache pointers are invalid.
3410h	No datasets in the cache to fulfil the request
3411h	Operation is not supported while there are operations outstanding.
3412h	Operation is not supported while datasets are locked.
3413h	The target dataset has not been located.
3414h	The target dataset has been located.
3415h	The cache has not be initialized.
3416h	Received an operation which is not supported in the current mode.
3417h	LF has attempted to rewrite a read-only dataset.
3418h	A test has taken too long to complete.
3419h	Too many pending LP cache operations
341Ah	Too many pending PP cache operations
341Bh	Received an inappropriate response
341Ch	Linked-list 'next' pointer is invalid
341Dh	CRAM transfer started but not finished
341Eh	Allocated insufficient CRAM
341Fh	Dataset is available in LM but the drive is not positioned to append.
3420h	Datasets in LM, Flush WITH_EOD required before the current operation
3421h	LM flushed but EOD is required before the current operation.
3422h	The specified dataset type is not supported by the operation.
3423h	The specified CRAM dataset type is not supported.
3424h	LF has attempted an operation away from EOD that can only be performed at EOD.
37FFh	Undefined error

Logical Pipeline Control (from 3800h)

Error	Description
3800h	No error. Synonymous with GOOD status.
3801h	Aborted operation
3802h	Busy. An operation request was received while in a transient state.
3803h	The value of a parameter received with a Logical Pipeline Control operation request falls outside its valid range.
3804h	Received an operation request while in a mode that does not allow that operation.
3805h	Operation aborted because of a write-behind error
3806h	Logical Pipeline Control has detected an unexpected File Mark during a Space operation.
3BFFh	A non-specific error has occurred in Logical Pipeline Control.

Mechanism Control (from 3C00h)

Error	Description
3C00h	No error
3C01h	Aborted command error
3C02h	Unsupported command error
3C03h	Bad parameter error
3D01h	Undefined data object error
3E01h	Wait for signal
3E02h	Object create failed
3E03h	Object execute failed
3E04h	Cartridge memory LPOS values suspect
3E05h	Notify client list full
3E06h	Position notify lost full
3E07h	Notify exists parameter different
3E08h	Notify event create failed
3E09h	Notify key map failed
3E0Ah	Notify index too large
3E0Bh	Too many MC command objects
3E0Ch	Cleaning cartridge expired
3FFFh	Undefined error

Non-Volatile Data Manager (from 4000h)

Error	Description
4002h	Invalid parameter
4003h	Data length exceed table length
4004h	Not a valid EEPROM
4005h	Checksum error. A write to EEPROM failed because the EEPROM is invalid.
4006h	A checksum read did not match the checksum written.
4007h	An unsupported data type was requested from the Non-Volatile Data Manager.
4008h	An unsupported data type was requested to be set in Non-Volatile Data Manager
4011h	PCA EEPROM missing
4012h	PCA EEPROM void
4013h	PCA EEPROM corrupt
4014h	PCA table invalid
4015h	PCA table 1 invalid
4015h	A failure occurred while trying to update the Read ERT log in the PCA EEPROM.
4016h	PCA table 2 invalid
4016h	A failure occurred while trying to update the Write ERT log in the PCA EEPROM.
4017h	A failure occurred while trying to update the Write Fault Counters log in the PCA EEPROM.
4018h	A failure occurred while trying to update the Tapes Used logs in the PCA EEPROM.
4021h	Head EEPROM absent
4022h	Head EEPROM void
4023h	Head EEPROM corrupt
4024h	Head table invalid
4025h	Head table 1 invalid
4026h	Head table 2 invalid
4027h	Head table 3 invalid
4028h	Head table 4 invalid
4031h	Mechanism EEPROM absent
4032h	Mechanism EEPROM void
4033h	Mechanism EEPROM corrupt
4034h	Mechanism table invalid
4035h	Mechanism table 1 invalid

Error	Description
4035h	A failure occurred while trying to update the Drive Fault logs in the PCA EEPROM.
4036h	Mechanism table 2 invalid
4036h	An Algorithm error occurred while trying to update the Drive Fault Logs in the EEPROM.
4037h	Mechanism table 3 invalid
4038h	Mechanism table 4 invalid
4039h	The Servo Fault could not be logged because of EEPROM access failure.
4041h	CM EEPROM absent
4042h	CM EEPROM void
4043h	The CM could not be written before an unload causing probable corruption in the CM.
4044h	An invalid protected page table was found.
4045h	A CRC error was discovered over the unprotected page table.
4046h	CM initialized. This is not really an error, it indicates a fresh cartridge.
4047h	CM invalid CRC
4048h	An invalid CRC over the Cartridge Manufacturers Information page was found.
4049h	An invalid CRC over the Media Manufacturers Information page was found.
404Ah	An invalid CRC over the Initialization Data page was found.
404Bh	An initialization table was request to be created for a CM with a valid initialization table in it.
404Ch	A failure occurred while trying to add a page descriptor to the unprotected page table.
404Dh	An unprotected page table entry was attempted with an invalid page ID.
4050h	An access to the tape directory was requested before it was read from the CM.
4051h	A CRC error was detected in the tape directory while being read.
4052h	Data for an illegal wrap section was requested from the tape directory.
4053h	The Buffer Manager does not have enough CRAM to hold the CM.
4054h	The write-protect operation was aborted because of a bogus initialization data address in CRAM.
4060h	An access to a non-existent EOD page was attempted.
4061h	An invalid CRC over the EOD page was found.
4062h	An access to a non-existent Initialization page was attempted.
4070h	An access to a non-existent Tape Write Pass page was attempted.

Error	Description
4080h	An access to a non-existent Tape Alert page was attempted.
4090h	There is no usage data available in the Cartridge Memory.
4091h	Usage pages are out of order and cannot be accessed.
4092h	The last updated usage page has a CRC error. The data is invalid.
40A0h	There is no mechanism sub-page data available in the Cartridge Memory.
40A1h	The last updated mechanism sub-page has a CRC error. The data is invalid.

Operating System (from 4400h)

Error	Description
4400h	'`vGiveSem`' failed to signal a semaphore

Physical Formatter (from 4C00h)

Error	Description
4C00h	C1 has finished before C2 is ready for the dataset.
4C01h	The physical formatter has been sent an invalid configuration name.
4C02h	The physical formatter has been sent an invalid configuration value
4C03h	C2 hardware is busy. The physical formatter C2 hardware is currently processing a dataset.
4C04h	The physical formatter C2 control DS0 register go bit is set.
4C05h	The physical formatter C2 control DS1 register go bit is set.
4C06h	The physical formatter C1 control register go bit is set.
4C07h	The physical formatter CCQ Reader control register go bit is set.
4C08h	The Read Chain Controller control go bit set. The physical formatter Read Chain Controller control register go bit is set
4C09h	Invalid write log channel number. The physical formatter has been asked for the error rate log for a channel which does not exist
4C0Ah	Invalid read log channel number. The physical formatter has been asked for the error rate logs for a channel which does not exist.

Error	Description
4C0Bh	Call-back timer not set. The physical formatter could not set the callback timer to enable the Hyperion read gate.
4C0Ch	Read Chain Controller DS0 stuck. The physical formatter Read Chain Controller DS0 is stuck.
4C0Dh	Read Chain Controller DS1 stuck. The physical formatter Read Chain Controller DS1 is stuck.

Physical Pipeline Control (from 5000h)

Error	Description
5000h	EOD not found
5001h	Black tape
5002h	EOD encountered
5003h	Undefined error
5008h	Invalid configuration number
5009h	Abort rejected continue
5015h	Waiting for reset before initializing
501Ch	Write fault
501Eh	Search active
501Fh	Mechanism command time-out; the control command never responded.
5020h	Command not allowed in this variant
5080h	Invalid tape type
5081h	The Error Rate Test has been aborted
5082h	Servo fault before done
5083h	PF reported a write error (excessive RWWs)
5084h	PF reported a read error (C2)
5086h	PF reported a streamfail
5087h	The error-rate test reached the C1 threshold.
5088h	Unknown notification. An unexpected mechanism control.
5089h	Data miscompare
508Ah	The drive has gone 4 metres since last dataset was reported.
508Bh	The speed requested for ERT s out of valid range.
508Ch	The notify for 4m give-up point is missing.
508Dh	EOT was reached before requested datasets were written.

Error	Description
508Eh	Start position requested for ERT s out of valid range
508Fh	Cannot find the expected dataset number
5090h	Blank check. Could not read anything off the tape in the last 4 metres.
5091h	Too many datasets returned while flushing.
5092h	Could not find the target during a space operation.
5093h	Could not find the target ACN during a search operation.
5094h	Write Pass on write has been corrupted.
5095h	ERT read more datasets than expected.
5096h	Logical Media has supplied an invalid dataset index.
5097h	Dataset written before BOW.
5098h	EOT reached during reading

Read/Write Control (from 5800h)

Error	Description
5800h	Success
5801h	Null point
5802h	Invalid parameter
5803h	No hardware
5804h	SPI transfer error
5805h	Prometheus set error
5806h	Hyperion set error
5807h	Daughter set error
5808h	Calibration did not complete
5809h	Servo bias status false
5820h	Could not set Prometheus 0 to default values
5821h	Could not set Prometheus 1 to default values
5822h	Could not set Prometheus 2 to default values
5823h	Could not set Prometheus 3 to default values
5830h	Could not set Hyperion 0 to default values
5831h	Could not set Hyperion 1 to default values
5840h	Could not initialize the Diagnostic Data `rwInitDiagnosticData`
58Ffh	Undefined error

System Architecture (from 6400h)

Error	Description
6401h	Formatter ASIC revision check failed. The ASIC is not a Gen 1 Formatter ASIC.
6402h	The processor idle time is less than 30%.

Tight Integ (from 6800h)

Error	Description
6801h	The Cmicro error handler function has been called (`cm_ErrorHandler`).
6802h	An implicit signal consumption has occurred.

Trace Logger (from 6C00h)

Error	Description
6C00h	TraceLogger initialization failed

Mechanical Interface (from 7400h)

Error	Description
7400h	No error
7401h	Aborted command
7402h	Unsupported command
7403h	Wrong number of parameters
7404h	Invalid parameter
7405h	This command is already in progress.
7406h	This command is not allowed now.
7407h	Command processing error
7409h	The command is obsolete.
740Ah	Incomplete initialization of the mechanism
740Bh	There was a timing fault in the servo interrupt.
740Ch	The mechanism type (`SensorRev`) specified in the mechanism EEPROM is either obsolete or unsupported.
740Dh	Obsolete command 300C
740Eh	Obsolete command 300D

Error	Description
740Fh	Invalid task. The current task for the servo system is of an unknown type. This is most likely caused by a firmware bug.
7410h	A Load command is not allowed at this time.
7411h	An Unload command is not allowed at this time.
7412h	A shuttle tape command cannot be executed at this time.
7413h	A Set Cartridge Type command cannot be executed at this time.
7414h	A Set Mechanism Type command cannot be executed at this time.
7415h	A Set Tension command cannot be executed at this time.
7416h	A Set Speed command cannot be executed at this time.
7417h	An Adjust Speed command cannot be executed at this time.
7418h	A Set Position command cannot be executed at this time.
7419h	The Cancel Set Position command cannot be executed at this time. Most likely because there is no previous set position command active.
741Ah	A Set Position and Speed command cannot be executed at this time.
741Bh	A Servo Calibration command cannot be executed at this time.
741Ch	An End of Tape Servo Calibration command cannot be executed at this time.
741Dh	A Servo Initialization command cannot be executed at this time.
741Eh	A Load Cartridge command cannot be executed at this time.
741Fh	A Grab Leader Pin command cannot be executed at this time.
7420h	A Load and Grab leader pin command cannot be executed at this time.
7421h	An Ungrab Leader Pin command cannot be executed at this time.
7422h	An Unload cartridge command cannot be executed at this time.
7423h	A Thread command cannot be executed at this time.
7424h	An Unthread command cannot be executed at this time.
7425h	A Recover Tape command cannot be executed at this time.
7426h	A Head Clean command cannot be executed at this time.
7427h	A Power-on Calibration command cannot be executed at this time.
7428h	A Set Notify command cannot be executed at this time.
7429h	A Wait Until Event command cannot be executed at this time, probably because the tape is not moving.
742Ah	A Set Head Position command cannot be executed at this time, probably because a servo calibration is in progress.

Error	Description
742Bh	A Set Tracking Offset command cannot be executed at this time, probably because a servo calibration is in progress.
742Ch	A DSP command to learn the VI offset is not allowed now because the tape is moving or another task is in progress.
742Fh	Debug ERROR code
7430h	Sensors are in a state that indicate that the sensors or Callisto is not working correctly.
7431h	Sensors are in a state that indicate that the sensors or Callisto is not working correctly on a load.
7432h	Sensors are in a state that indicate that the sensors or Callisto is not working correctly on a grab.
7433h	Sensors are in a state that indicate that the sensors or Callisto is not working correctly on an ungrab.
7434h	Sensors are in a state that indicate that the sensors or Callisto is not working correctly on an unload.
7435h	The RD sensor has stopped toggling, probably because the loader mechanism is blocked or the motor is not working.
7436h	It is unsafe to load the cartridge. A runaway condition of the FRM has been detected, probably because the tape is broken
7437h	Unexpected LP on a grab. One (and only one) of the LP sensors has been asserted at the beginning of the grab.
7438h	Unexpected LP at the start of a grab. One (and only one) of the LP sensors has been asserted at the beginning of the grab. This is logged but not a failure.
7439h	The write protect sensor does not match the expected state.
7440h	Callisto Bus test error
7450h	In transit after initialization
7451h	Ungrab after initialization
7452h	Unknown after initialization
7453h	Timed out waiting to send a command to get DSP head-cleaning information
7454h	Timed out waiting for DSP response with head-cleaning information
7455h	Timed out waiting to set up DSP for a head-cleaning command
7456h	Timed out waiting for DSP response to head-cleaning setup
7457h	Timed out waiting for DSP to complete the head-cleaning command
7458h	Head-cleaning engagement time-out

Error	Description
7459h	Head-cleaning parking time-out
745Ah	Head-cleaning cycling time-out
745Bh	The state of the sensor read at initialization are illegal. The results make no sense.
745Ch	Timed out waiting to restore DSP after a head-cleaning command
745Dh	Timed out waiting for DSP during post-head-cleaning restoration
7460h	DSP download error
7461h	Invalid DSP opcode error
7462h	Unable to send a DSP command
7463h	Unable to send a DSP seek command
7464h	DSP failed to complete a seek command
7465h	Send long-term DSP command time-out
7466h	Sendshort-term DSP command time-out
7467h	DSP long-term command protocol error
7468h	DSP short-term command protocol error
7469h	Too many parameters on DSP Long-term command
746Ah	Too many parameters on DSP Short-term command
746Bh	Too many results on DSP Long-term command
746Ch	Too many results on DSP Short-term command
746Dh	Long-term DSP command already in progress
746Eh	Short-term DSP command already in progress
746Fh	Long-term DSP command completed but not in progress
7470h	Short-term DSP command completed but not in progress
7471h	Unable to send a DSP Learn VI offset command
7472h	DSP failed to complete a Learn VI offset
7473h	Unable to send a DSP CalVi command
7474h	DSP failed to complete a CalVi command
7475h	Too many data points requested
7476h	No scope data available from DSP
7477h	DSP failed to complete the command during the initialization process
7478h	Unable to send DSP tuning parameters
7479h	DSP failed to boot properly
747Ah	Time-out on sending the Clear DSP Fault log

Error	Description
747Bh	Time-out on completing the Clear DSP Fault log
747Ch	Unable to send DSP Head Clean command
747Dh	An abort command was requested while one is already in progress.
747Eh	An abort command has timed-out while waiting for the tape to stop.
747Fh	An Adjust Speed command was requested while one is already in progress.
7480h	General load failure
7481h	EP did not transition on a load, probably because no cartridge was present.
7482h	CD did not transition on a load
7483h	CG did not transition on a grab
7484h	LP did not transition on a grab
7485h	Too many retries to recover on a load or unload
7486h	Cartridge not free to rotate when Cartridge Down
7487h	The RD sensor stopped toggling while EP during a load.
7488h	The RD sensor stopped toggling while IT during a load.
7489h	The RD sensor stopped toggling while CD during a load.
748Ah	The RD sensor stopped toggling while CD during a grab.
748Bh	The RD sensor stopped toggling while LP during a grab.
748Dh	FRM runaway. Too much rotation was detected in the cartridge before it was threaded.
748Eh	A grab was requested but the cartridge was not loaded
748Fh	Sensors indicate that the grabber unexpectedly moved into a grab position during a load operation.
7490h	While parking the LP, the LM voltage was increased from .25V to .5V.
7491h	While parking the LP, the LM voltage was increased from .5V to .75V
7492h	While parking the LP, the LM voltage was increased from .75V to 1.0V
7493h	While threading, the LM voltage was increased from .25V to .5V
7494h	While threading, the LM voltage was increased from .5V to .75V
7495h	While threading, the LM voltage was increased from .75V to 1.0V
74A0h	General unload failure
74A1h	EP did not transition while unloading
74A2h	CD did not transition while unloading
74A3h	CG did not transition while ungrabbing
74A4h	LP did not transition while ungrabbing

Error	Description
74A6h	RD stopped toggling while CG during ungrab
74A7h	RD stopped toggling while LP during ungrab
74A8h	RD stopped toggling while CD during ungrab
74A9h	RD stopped toggling while CD during unload
74AAh	RD stopped toggling while IT during unload
74ACh	Too much rotation of the cartridge was detected while the tape was not threaded
74ADh	The load, unload, grab or ungrab operation timed out.
74C0h	Time-out while deslacking the cartridge
74C1h	Emergency stop error
74C2h	Already past target position
74C3h	Set speed time-out error
74C4h	Time-out waiting for an LPOS
74C5h	Fatal reel fault error
74C6h	Safety lit stop reached
74C7h	LPOS calculation with invalid LP0
74C8h	Missed target position
74C9h	Previous tape motion command in progress
74CBh	Unthreading time-out error
74CCh	Remove slack process timed-out
74CDh	Leader may have disconnected
74CEh	Time-out waiting for radii estimate
74CFh	Radii estimation process failed
74D1h	Invalid cartridge type
74D2h	Cal reel driver offset time-out
74D3h	Time-out waiting for the specified event
74D4h	Front-reel motor hall sensor fault
74D5h	Back-reel motor hall sensor fault
74D6h	The deslacking process timed out and did not complete, probably because the back reel motor failed to rotate.
74D7h	Threading time out while waiting for half moon to pass the first roller.
74D8h	Timed out waiting for tape to reach position for speed-up during a thread.
74D9h	Time out while waiting for tape to reach the position to stop threading.

Error	Description
74DAh	An unthread command was issued and aborted a tape motion operation that was already in progress.
74DBh	The cartridge type has not been specified either from LTO-CM or through a serial port command.
74DCh	The tape speed reported by the DSP is significantly different from the tape speed indicated by the hall sensors.
74DDh	Specified value of tension is either too high or too low.
74DEh	The panic stop process timed out and did not complete properly.
74DFh	Timed-out waiting for the proper tape tension to be established.
74E0h	Head selection time-out
74E1h	Unable to position the head
74E2h	Speed too low for enabling the heads
74E3h	Speed too low for the head servo
74E4h	Speed too low for sensor calibration
74E5h	A DSP seek command was attempted while the tape speed was zero.
74E6h	DSP sensor calibration command was attempted while the tape speed was zero.
7500h	First write fault
7501h	Write fault: it has been too long since a valid LPOS was read, so writing is not allowed.
7502h	Write fault: DSP tracking recovery operations are in progress so writing is not allowed.
7503h	Write fault: tape motion start-up operations are incomplete so writing is not allowed.
7504h	Write fault: DSP is not tracking properly on the tape, writing is not allowed.
7505h	Write fault: the current tape speed is too low so writing is not allowed.
7508h	Write fault: DSP idle
7509h	Write fault: DSP calibrating
750Ah	Write fault: DSP VI track follow
750Bh	Write fault: DSP tape off-track
750Ch	Write fault: DSP demod channel out
750Dh	Write fault: DSP seek
750Eh	Write fault: DSP uPVI
750Fh	Write fault: write unsafe
7510h	Unknown write fault

Error	Description
7511h	Multiple write faults
7512h	Last write fault
7600h	Set Speed command invalid parameter
7601h	Adjust Speed command invalid parameter
7602h	Set Position command invalid parameter
7603h	Set Head Position command invalid parameter
7604h	Set Head Table command invalid parameter
7605h	DSP Statistics command invalid parameter
7606h	Get Servo Fault command invalid parameter
7607h	Set Tracking Offset command invalid parameter
7608h	Set Notify command invalid parameter
7609h	Clear Notify command null handle
760Ah	ATS Diagnostics command invalid parameter
760Bh	Hall Calibrate command invalid parameter
760Ch	Radius Calibrate command invalid parameter
760Dh	Wait Until Event command invalid parameter
760Eh	Convert LPOS command invalid parameter
760Fh	Shuttle command invalid parameter
7610h	Get DSP fault log invalid parameter
7620h	Set speed operation timed out during a recover tape command.
7621h	Timed out waiting for the pin sensors to indicate almost parked.
7622h	Timed out waiting for the pin sensors to indicate fully parked.
7623h	An unthread timed out waiting for the full leader pin seating tension to be established.
7624h	Cycling the pull-in tension did not achieve pin-park.
7625h	Rethreading and then unthreading again did not get the leader pin parked.
7626h	Timed out during the rethread/re-unthread recovery while waiting for almost parked.
7627h	All recovery algorithms have been exhausted and still unable to park leader pin.
7628h	Rethread recovery operation timed out waiting for the tape to come to a stop.
7629h	Rethreading timed out while waiting for the tape to reach the required position.
762Ah	Deslacking process did not complete., probably because the back reel motor failed to rotate.
762Bh	The leader pin was parked as indicated by both LP sensors but then came unparked.

Error	Description
762Ch	The tape has been recovered and leader pin parked but the original operation failed and was abandoned.
762Dh	Rethreading timed out while waiting for the tape to reach the required position.
762Eh	Rethread recovery operation timed out waiting for the tape to come to a stop.
762Fh	A special unthreading recovery operation was needed to un-jam the leader block.
7630h	An iteration of the special unthreading recovery operation did not succeed.
7631h	The stop tape operation took longer than expected.
7632h	An attempt was made to stop the tape while still too far away from the specified position.
7633h	An abort command was issued and stopped the tape motion operation that was already in progress.
7634h	The tape thickness is too great to be handled properly by the servo system.
7635h	An ATS speed change operation (AdjustSpeed) timed out waiting for tape to reach target speed.
7636h	An ATS speed change operation (AdjustSpeed) was attempted while the tape was not moving.
7637h	While trying to park the pin, LP2 was seen, but LP1 was not seen after rotating the grabber CCW.
7638h	Threading timed out while waiting for the half moon to seat onto the back reel.
7639h	Tape motion apparently stopped while waiting for head positioning to complete.
763Ah	Unthread timed out during the initial rewind of tape back into the cartridge.
763Bh	Timed out during an operation to set tape position and speed.
763Ch	Timed out during an operation to set the tape position.
763Dh	Timed out during a RecoverTape operation.
763Eh	The front reel did not rotate during the tape slack removal process.
7680h	The DSP was commanded to re-lock onto servo code. (This is a recovery algorithm.)
7681h	A retry was necessary on a DSP seek command. (This is a recovery algorithm.)
7682h	A retry was necessary on a DSP VI-sensor cal command. (This is a recovery algorithm.)
7683h	A retry was necessary on a DSP azimuth cal command. (This is a recovery algorithm.)
7684h	A retry was necessary on a DSP command to learn the VI-offset. (This is a recovery algorithm.)
7685h	Unable to thread. An ungrab/regrab/rethread recovery process will now be attempted.

Error	Description
7686h	The thread operation is being retried because the pin detect sensor indicates parked when not parked.
7687h	The threading recovery could not get the tape stopped in a reasonable time period.
7688h	Timed out waiting for a regrab to complete before threading.
7689h	Timed out trying to read the media manufacturer's information.
768Ah	A faulty LP sensor has made it necessary to detect pin parking via FRM stall.
768Bh	Attempt to park failed. An LP sensor was most likely asserted when it should not have been.
768Ch	A VI cal was necessary to recover a DSP seek command failure. (This is a recovery algorithm.)
76EBh	The drive has cooled and the cooling fan has been turned off.
76ECh	The drive is getting too hot and the cooling fan has been turned on.
76EDh	The drive has cooled; resuming normal tape speeds.
76EEh	The drive is getting too hot; tape speed is now being reduced to a minimum.
76EFh	ASIC temperatures are too high. Operations must stop and the cartridge must be ejected.
76F0h	The address into the main DRAM buffer must be on an even byte boundary.
76F1h	The address into the main DRAM buffer is outside the range allowed for the servo system to use.
76F2h	The specified mode is not valid.
76F3h	The specified scope channel bit width is not supported.
76F4h	The specified scope trigger position is too large compared to the specified number of data packets in the trace.
76F5h	The length of the buffer must be larger than zero and an even number.
76F6h	The specified source number is not valid.
76F7h	The specified scope buffer format parameter is not valid.
76F8h	A reel driver calibration factor is out of range.
76F9	A reel driver calibration factor for static torque loss is out of range.
76Fa	A reel driver calibration factor for dynamic torque loss is out of range.
76FB	The temperature is above the maximum limit.
76FC	The temperature is below the minimum limit.
76FD	EEPROM values are unavailable. The default servo tuning values are being used instead.
76FEh	Previous fault conditions have made it unsafe to thread this cartridge.

Error	Description
76FFh	The tape temperature is too high. Operations must stop and the cartridge must be ejected.
7700h	The base number for constructing DSP error codes. This is not an actual error.
7701h	DSP fault: TMS320 was just reset due either to hardware pin assertion or receipt of the Reset command.
7702h	DSP fault: the DSP checksum failed after a hardware/software reset.
7703h	DSP fault: unsupported command opcode
7704h	DSP fault: illegal command sequence
7705h	DSP fault: The Alert bit was set during a seek or CalibrateVI command.
7706h	DSP fault: the DSP was asked to do a tape seek when the uP said this was not a safe operation to do.
7707h	DSP fault: a seek or VI calibration command was issued but the mechanism has not learned the VI offset yet.
7708h	DSP fault: the stroke measured by the VI sensor hardware was not large enough.
7709h	DSP fault: excessive actuator power amp offset
770Ah	DSP fault: main memory uP timeout.
770Bh–770Fh	DSP faults: spare
7710h	DSP fault: unable to find a top servo band.
7711h	DSP fault: unable to lock to track 0 on a top servo band.
7712h	DSP fault: unable to verify band ID on a top servo band.
7713h–771Fh	DSP faults: spare
7720h	DSP fault: the track-following loop could not stay at the desired set point.
7721h–772Fh	DSP faults: spare
7730h	DSP fault: could not stay locked to the tape servo code.
7731h–773Fh	DSP faults: spare
7740h	DSP fault: no tape servo data during seek acceleration phase.
7741h	DSP fault: acceleration time-out fault
7742h	DSP fault: spare
7743h	DSP fault: no tape servo data during the seek deceleration phase
7744h–7745h	DSP faults: spare
7746h–7747h	DSP faults: seek failures during gross settle
7748h–774Ah	DSP faults: spare
774Bh	DSP fault: no tape servo data during seek fine settle phase

Error	Description
774Ch	DSP fault: too few samples to generate an azimuth correction
774Dh–774Fh	DSP faults: spare
77*nn* (*nn*=50h–FEh)	DSP fault Code *nn*
77FF	Denotes the end of DSP error codes. This is not an actual error.

Exception Handler (from 7800h)

Error	Description
7800h	Unrecognized exception

SPI Interface (from 7C01h)

Error	Description
7C01h	Buffer overflow
7C02h	Time-out error

Cartridge Memory (from 8000h)

Error	Description
8000h	Address out of limits
8001h	SPI writing problems
8002h	Wrong number of bits returned
8003h	Nack error
8004h	Unrecognized data received
8005h	SPI reading problems
8006h	Parity error
8007h	Collision error
8008h	Overflow error
8009h	Underflow error
800Ah	Overflow error on sending
800Bh	Number of bits on data receive error
800Ch	Impossible address situation
800Dh	Invalid configuration name

Error	Description
800Eh	Invalid configuration value
800Fh	CRC error
8010h	The serial number check failed
8011h	Error bit set
8012h	Type of transponder not recognized
8013h	RF channel already opened
8014h	RF channel already closed
8015h	EOT polled to

Critical Section (from 8C00h)

Error	Description
8C00h	End section no begun. `CRSEndCritIntSect` was ended without `CRSBegIntSect`.
8C01h	Begin section ints off. `CRSBegCritIntSect` found ints already off.

Gen 1 Formatter ASIC/Whitewater Interface (from F800h)

Error	Description
F801h	GWIF pending
F802h	GWIF no change

Other (FFFFh)

Error	Description
FFFFh	Last operation status.

glossary

ANSI American National Standards Institute, which sets standards for, amongst other things, SCSI and the safety of electrical devices.

autoload When a tape cartridge is inserted, a tape drive with autoload will automatically load it without the host having to send a load command. If a drive does not have autoload, the drive will take no action until it receives a load command.

compression A procedure in which data is transformed by the removal of redundant information in order to reduce the number of bits required to represent the data. This is basically done by representing strings of bytes with codewords.

ECMA European Computer Manufacturers Association. The European equivalent of ANSI.

host The host computer system acting as controller for the drive.

load The process in which the drive takes in an inserted cartridge and goes online.

LUN Logical Unit Number, by which different devices at a particular SCSI ID can be addressed individually. The drive has a fixed LUN of 0.

LVD Low-Voltage Differential. *See* **SCSI**.

offline The drive is offline if the tape is currently unloaded or not in the drive. The host has limited access, and cannot perform any commands that would cause tape motion. The host can, however, load a tape, if one is inserted, and can execute any diagnostic tests that do not require tape motion.

online The drive is online when a tape is loaded. The host has access to all command operations, including those that access the tape, set configurations and run diagnostic tests.

SAN Storage Area Network. A dedicated, high-speed network that establishes a direct connection between storage elements and servers. The hardware that connects workstations and servers to storage devices in a SAN is referred to

as a fabric. The SAN fabric enables any-server-to-any-storage device connectivity through the use of Fibre Channel switching technology.

SCSI Small Computer System Interface—a standard command specification and command set that enables computers and peripherals to communicate with each other. HP's Ultrium drives adhere to the SCSI specifications (see Chapter 1, "Interface Implementation" in Volume 3, the **SCSI Interface**, of the HP Ultrium Technical Reference Manual) and support all features required by those standard.

Single-Ended and Low Voltage Differential SCSI

These terms define how the signals are transmitted along the cable.

With *single-ended* (SE) SCSI, each signal travels over a single wire and each signal's value is determined by comparing the signal to a paired ground wire. Signal quality tends to decrease over longer cable lengths or at increased signal speed.

With *low voltage differential* (LVD) signaling, signals travel along two wires and the difference in voltage between the wire pairs determines the signal value. This enables faster data rates and longer cabling with less susceptibility to noise than SE signaling and reduced power consumption.

Narrow and Wide, Fast, Ultra and Ultra2 SCSI

Narrow SCSI devices can transfer data one byte at-a-time (and are sometimes called "8-bit SCSI" devices). They can conform to either the SCSI-2 or SCSI-3 protocols. They have a 50-pin connection to the SCSI bus.

Wide SCSI devices can transfer two bytes of data simultaneously ("16-bit SCSI"). They usually have a single, 68-pin connection to the SCSI bus. (This physical arrangement is part of the SCSI-3 specification.) They may support either SCSI-2 or SCSI-3 protocols. Wide and narrow devices can simultaneously be connected to the same bus without problem, provided certain rules are followed.

Fast SCSI can transfer data at up to 20 MB/s wide, using a cable of up to 6 meters total length.

Ultra SCSI can transfer data at up to 40 MB/s wide, but the cable length cannot exceed 3 meters (it is also known as "Fast20").

Ultra2 SCSI can transfer data at up to 80 MB/s wide, using a cable of up to 25 meters total length for a single device, or up to 12 meters for two or more devices (it is also known as "Fast40").

Ultra3 or *Ultra160* can transfer data at up to 160 MB/s wide. Cable lengths are as for Ultra2.

Ultra4 or *Ultra320* will transfer at up to 320 MB/s.

Ultra SCSI supports both SE and LVD interfaces. In normal situations, slower devices can coexist with faster devices, and narrow devices can be used on the same SCSI bus as wide devices using a suitable adapter.

HP's Generation 1 Ultrium drives are Ultra2, wide SCSI-3 compatible devices. They can be used with both LVD and SE host bus adapters.

Generation 2 Ultrium drives are Ultra160, wide SCSI-3 compatible.

single-ended *see* **SCSI**

Tape log The Tape log contains details of the history of a tape, the total number of groups written, of RAW retries, of groups read, and of loads. The log is copied into RAM when the tape is loaded into the drive, updated as the tape is used, and loaded back on the tape when it is unloaded.

TapeAlert A set of 64 flags is held in the TapeAlert log that indicate faults or predicted faults with the drive or the media. For example, the Not Data Grade flag is set if the drive detects that a non-MRS tape is loaded. By reading this log, host software can inform the user of existing or impending conditions, and can, for example, advise the user to change the tape.

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