TECHNICAL BRIEF

The L20, L40 and L80 tape libraries

A technical overview

APRIL 2004

1 INTRODUCTION

The L20, L40 and L80 tape libraries are the newest members of StorageTek's L-Series™ tape libraries set. These products are designed to provide optimal flexibility in drive technology selection and capacity upgrade. The L20, L40 and L80 tape libraries are specifically targeted at small data centers and workgroups, providing configurations with an upgrade path that extends from one drive and 10 cartridges up to eight drives and 80 cartridges.

2 DESIGN METHODOLOGY

The L20, L40 and L80 tape libraries were designed by the same engineering team that created the TimberWolf® 9730 tape library as well as the larger L180 and L700e tape libraries. The goal of the design team was to bring the features and reliability of StorageTek's larger tape libraries into the small data center at an affordable price.

Over the past 15 years, StorageTek's engineers have mastered the art of reliable robotics design. While other tape library vendors will purchase off-the-shelf components and attempt to fit them into their applications, StorageTek designs and manufactures all of the key components used inside their libraries. Extensive life testing is performed on individual robotics components prior to assembling the first library. By rigorously testing the individual components, the highest reliability of the assembled unit is maintained.

Significant engineering effort has been applied to minimizing the number of components needed to perform a function, resulting in a clean, reliable design. For example, a single processor card operates the robotics, operator panel, Web page server and SCSI interfaces. It also monitors fan status, temperature, drive status and library operating status. Many common components are used across the entire series. Just as an automobile manufacturer will use a proven engine technology across many vehicle models, StorageTek uses the same processor card, power supplies and even a single version of library firmware functions across the entire series of L20, L40 and L80 tape libraries.

3 KEY FEATURES

Building upon the successful TimberWolf 9730 tape library, the smaller L-Series tape libraries incorporate many new features such as:

- Scalable capacity from one to eight drives and 10 to 80 cartridges
- True mixed-media tape drive and tape cartridge support (DLT IV tape cartridge, Super DLT tape cartridge, Linear Tape Open (LTO) Ultrium tape drive)
- Automatic sensing and configuration of library capacity, drives and cartridge types
- Hot-swappable tape drives, power supplies and fans
- Digital camera-based robotics position calibration and cartridge barcode label reader
- Embedded library status tool for Web-based monitoring of library, tape drives, software and tape media cartridges. Also for remote code download and reporting. (Netscape or Internet Explorer)
- Fibre Channel SAN attachment using an integrated intelligent Fibre/SCSI router
- LVD/SE (Low Voltage Differential/Single Ended) or HVD SCSI (High Voltage Differential Small Computer System Interface) host interfaces
- SCSI-3 remote copy support for "hostless" backup
- Redundant power supplies — with the ability to operate from two separate AC circuits (L40 and L80 tape libraries only)
- Auto-ranging power supply for 110V or 220V operation
- Continuous monitoring and reporting of library status, drive status, fan status, power supply status and library temperature
- SNMP (Simple Network Management Protocol) agent reporting of monitored events for remote administration using Tivoli, OpenView, UniCenter or other third-party software
- Operator configurable warning and shutdown temperature thresholds
- Cartridge import/export slot(s)
- Simple and flexible library capacity upgrades
- Guided installation utility CD.

4 LIBRARY OPERATION

When an L-Series tape library is powered on, the control processor performs several basic system checks. The robotic mechanisms slowly begin motion to check for any obstacles in the robotics path and to locate the end-of-travel positions for each mechanism. Using this information, the library firmware then determines which tape library (L20, L40 or L80) it is controlling. Once the library type is determined, the hand is then positioned in front of a camera calibration label and operation of the camera system is verified. During this procedure, the camera "exposure time" is properly adjusted for the ambient light. After the camera is calibrated, the "cartridge present" proximity sensor is calibrated.

The next operation is the audit process. This audit process includes using the digital camera to perform a mechanical calibration to align the picker mechanism to the cell and drive locations as well as inventorying all storage cells and import/export locations. By having both a camera and a simple proximity sensor, the library system can perform a rapid inventory and readily distinguish between labeled cartridges, unlabeled cartridges and empty cell locations.

During the audit, tape cartridge barcode labels are read. The barcode labels contain a unique serial number and a cartridge type identifier. StorageTek tape libraries use the cartridge type identifier so that a mount request matches a tape cartridge with a valid drive type. For example, in a tape library with both DLT and LTO Ultrium tape drives/cartridges, a mount of a DLT cartridge to an LTO Ultrium tape drive is prohibited. If the cartridge type does not match the drive type, the mount request will be rejected and an error will be returned to the host.

In keeping with other StorageTek tape libraries, the smaller L-Series libraries all support true mixed cartridge type operation. This allows easy data migration to new technologies. Other library vendors require removal and replacement of storage cells, import/export cells and even a new robotics gripper to upgrade their library with new tape drives.

Unlabeled cartridges are handled in one of two ways. In a single cartridge/drive-type configuration, all unlabeled cartridges are assumed to be of the proper cartridge type and a mount request will result in a cartridge mount to the requested tape drive. In a mixed cartridge/drive-type environment, the unlabeled cartridge type will be unknown and a request to mount an unlabeled cartridge will be rejected. Cartridges must have bar code labels, in order to be mounted in a mixed cartridge/drive-type configuration.

The library, by communicating through the library-to-tape-drive serial interface, automatically determines both the quantity and type of installed tape drives. The library detects the presence of a tape drive and polls each detected drive to determine the drive type. Once the drive type is established, the library will adapt to that drive's unique protocol and request further information on the tape drive operating status. This information is displayed on the operator panel and via the Web interface.

In addition to performing a cartridge inventory, the library also uses the camera to view mechanical calibration targets. These targets are used to compensate for any mechanical variations, allowing the library to accurately position to all cartridge and tape drive locations. The digital camera system provides resolution of +/- .002 inches (+/- .0508 millimeters). This helps to reduce wear on the cartridges, tape drives and storage cells.

Once the audit is complete, the hand is then moved to a "safe" location and the operation of the cartridge picker mechanism is verified. The tape library is then ready to receive commands from the host.

5 ROBOTIC HAND OPERATION

When a mount request is received from the host, the robotics hand is positioned to the proper cell location to retrieve the requested cartridge. The cartridge retrieval hook is positioned into a notch on the cartridge. Once the hook is seated, the cartridge is then retracted into the hand to be transported to the tape drive. When the cartridge is properly positioned, it is gently pushed into the drive.

After a cartridge is ejected from the tape drive, the hand will again hook the cartridge, pull the cartridge into the hand and place it back into the storage cell. A retention feature is designed into each storage cell, which mates with a recess in the tape cartridge. This means that the cartridge remains seated once it is placed into a storage cell.

The hand is designed to prevent a cartridge from being dropped, even in the event of a power loss. If power is lost with a cartridge in the hand, the library will automatically detect this when the power resumes. The cartridge will then be placed back into its original location. In addition, the host will receive a SCSI unit attention for a "power on reset condition," as well as a status indicating that the mount request failed and should be reinitiated.

6 VISION SYSTEM

The digital camera system uses a 2000 pixel CCD (Charge Coupled Device) to perform barcode reading and position calibration for storage cell, import/export slot and tape drive accesses. The same proven barcode reading firmware that is used in the larger L180/L700e tape libraries has been applied to the L20/L40/L80 series of tape libraries. The camera system uses a highly reliable LED light source for illumination. The camera firmware also has the ability to dynamically adjust the camera exposure time to compensate for variations in ambient lighting. StorageTek's patented "N" target allows the library to achieve fine positioning in two dimensions using a single row of scan information from the CCD.

7 INTERFACES

7.1 SCSI INTERFACE

The L20, L40 and L80 tape libraries support LVD/SE and HVD SCSI host attachment. The library controller card contains drivers for both LVD and HVD SCSI. By connecting the internal "Y" ribbon cable to the proper connector on the controller and setting a jumper block to the proper position, either LVD/SE or HVD mode is selected. For the L20 tape library, this operation involves removing the top cover of the library and reaching into a tight compartment to move the cable and jumper. Although field reconfiguration is possible, StorageTek recommends ordering the library with the proper LVD or HVD interface selection to avoid having a trained service person reconfigure the L20 tape library.

The L40 and L80 tape libraries use the same controller card as the L20 tape library and are configured in the same manner. Easy access to the internal ribbon cable and jumpers in the L40 and L80 tape libraries can be achieved by removing the retaining screws from the electronics module at the rear of the library and sliding the electronics module out approximately six inches.

7.2 FIBRE CHANNEL INTERFACE

Fibre Channel interface attachment is supported via an optional internal router. This router allows bridging from Fibre Channel to the LVD SCSI drives and library interface. The internal router is functionally compatible with the Crossroads 4x50 product and, when combined with the appropriate host backup software, supports features such as SCSI remote copy for hostless backup operation.

7.3 FUTURE INTERFACES

Additional interface options, such as Gigabit Ethernet/iSCSI, will be incorporated into the L-Series tape libraries as the market for these interfaces develops.

8 DIAGNOSTICS

The L-Series tape libraries provide continuous run-time diagnostics with the ability to report over 400 unique error conditions. Operations such as robotics motion, host interface operation, tape drive operating status and environmental conditions are continuously monitored.

8.1 ENVIRONMENTAL MONITORING

The environmental conditions that are monitored in the L20/L40/L80 tape libraries include cooling fans and operating temperature. If a library or tape drive cooling fan fails, or if the fan rotation speed falls below 100 RPM, an alarm signal is activated by the fan. The processor card monitors this signal and will report a fan failure. A temperature sensor is located on the processor card, which receives airflow from the cartridge storage area. Two temperature alarm settings are programmable from the operator panel. The **Warning** alarm will notify the operator when the warning threshold is exceeded. The **Shutdown** alarm will notify the operator if the shutdown temperature is exceeded. If the threshold is exceeded, the library will reject further SCSI mount requests until the temperature drops below the shutdown threshold.

8.2 POWER SYSTEM MONITORING

When a redundant power supply option is installed in the L40 or L80 tape library, the system monitors the power supply status and reports any failure of a single power supply.

8.3 LIBRARY SELF-TEST

The library self-test utility may be activated from the operator panel. The self-test utility will verify proper operation of the library by directing the hand to move each cartridge in and out of the respective cell locations. If a cartridge with a DGxxxx label is installed, the picker will also mount and dismount the DG cartridge to each tape drive. (Note: A cartridge with a label that has first two characters "DG" is recognized by the library as a diagnostic cartridge.)

8.4 WEB-BASED MONITORING

The library status tool provides:

> Web-based monitoring
> Real-time (no polling)
> Out-of-band via Ethernet port connection
> Remote code download
> Report generation
> Fax or e-mail reporting to technical support.

8.5 ERROR REPORTING

When an error is detected, a fault symptom error code is recorded in the library's internal event log. If the error inhibits library operation, it will be reported in several ways. 1) The service-required LED on the operator panel will be activated; 2) an error will be logged in the internal library event log; 3) the Web interface will display environmental error status (for revision 2.02 or higher firmware); and 4) an SNMP trap event notification will be posted via the Ethernet network (future firmware release — fall 2002).

9 TAPE DRIVE CLEANING

Tape drive read/write integrity can sometimes be affected by dirt or debris that may accumulate on the tape head. This problem can often be remedied by using a cleaning cartridge to clean the tape head. The host backup software frequently manages tape drive cleaning.

Each time a cleaning cartridge is inserted into a tape drive, the tape drive uses the next "unused" segment of the cleaning tape to perform cleaning. A typical cleaning cartridge can be used for 15 to 20 cleanings before it must be replaced. The number of cleaning passes that have been used on a cleaning cartridge may be viewed via the operator panel.

If the backup application does not manage tape drive cleaning, the library auto-clean function may be enabled from the library operator panel. When the auto-clean function is enabled, the library will monitor each tape drive and, when a cleaning request is received, the library will use the cleaning tape to perform the cleaning operation. In order for auto-clean to function properly, a cleaning cartridge must be placed in a designated cleaning cell location within the library. (Note: A cartridge with a label that has first three characters "CLN" is recognized by the library as a cleaning cartridge.) The library auto-clean function can manage a single cleaning cartridge type and therefore is not recommended in a mixed cartridge/drive type environment.

10 SERVICE

Tape drives, fans and redundant power modules are all designed with the ability to be serviced or replaced without powering down the library system. When a fan or power module is replaced, the library automatically detects the presence of the new component and verifies its proper operation. Once proper operation is verified, the failure indicator will be removed and the library will resume normal operation.

All tape drive modules are interchangeable among the L20, L40 and L80 tape libraries. The modules are designed to allow the drives to be removed from the SCSI bus without breaking the SCSI bus daisy-chain connection. Following installation of the new tape drive, the library will detect the new replacement drive and automatically reassign the SCSI ID for that location to the new tape drive, allowing the library to resume normal operation.

Library firmware upgrades may be performed in one of two ways. 1) Download code with Library Status tool via Ethernet-based Web interface, which is supported in firmware release version 2.02 or higher. 2) Firmware may be downloaded through a serial port (located on the back panel of the library) using a PC with a standard Z-Modem protocol. An updated glossary of error codes is provided along with each firmware update.

11 UPGRADABILITY

With today's rapidly changing markets, StorageTek recognizes the need for investment protection in data storage equipment.

The L20/L40/L80 series of tape libraries was designed to support DLT, SDLT and LTO Ultrium tape drives. Should one particular technology fall behind, migration to another technology in the L-Series tape libraries is simply a matter of installing a new tape drive. In addition, internal bridge support and a modular CompactPCI (Peripheral Component Interconnect) interface bus allows the L-Series products to be easily adapted to new interface technology as it emerges in the market.

Growth in storage capacity can be achieved in several ways:

11.1 DRIVE TECHNOLOGY UPGRADE

The forecast for technology improvements in tape drives appears to be doubling cartridge capacity approximately every two years. For some, just replacing the tape drives every two years to double capacity may provide a reasonable solution to meeting their growth requirements. The L-Series tape libraries make this transition easy by allowing migration to the new technology with true mixed-cartridge capability.

11.2 LIBRARY EXCHANGE PROGRAM

If a customer's data growth outpaces the natural tape technology evolution, an L-Series tape library may be exchanged for a larger model through a convenient upgrade program. Through this program, the customer receives credit for the capacity that they have previously purchased when they trade-up to the next larger library.

11.3 LIBRARY GROWTH UPGRADE

If a customer already realizes that their future storage requirements will have substantial growth, they may choose to purchase a larger capacity library at a more economical price point with only a portion of the library's capacity enabled for use. At a later date, the additional capacity may be purchased and enabled by simply plugging an electronic upgrade key onto the back of the library.

12 LIBRARY MOUNTING

12.1 RACK MOUNT

The L20, L40 and L80 tape libraries are available in standard 19-inch wide rack-mount versions. Each unit will fit conveniently into a basic 30-inch deep rack. A customer has the option of placing the unit on their own shelf or brackets or ordering a 1U (Unit) rack shelf kit or a low profile rail kit from StorageTek.

12.2 DESKTOP

The L20 and L40 tape libraries may be placed on a desktop. A desktop kit is available, which provides a cover for the library and rubber feet, which are placed on the bottom of the unit.

12.3 DESK SIDE

The L80 tape library is available in a desk-side version. A desk-side kit may be ordered, which provides a cover for the library and base onto which the library is placed. The base contains rolling castors, allowing the library to be easily relocated

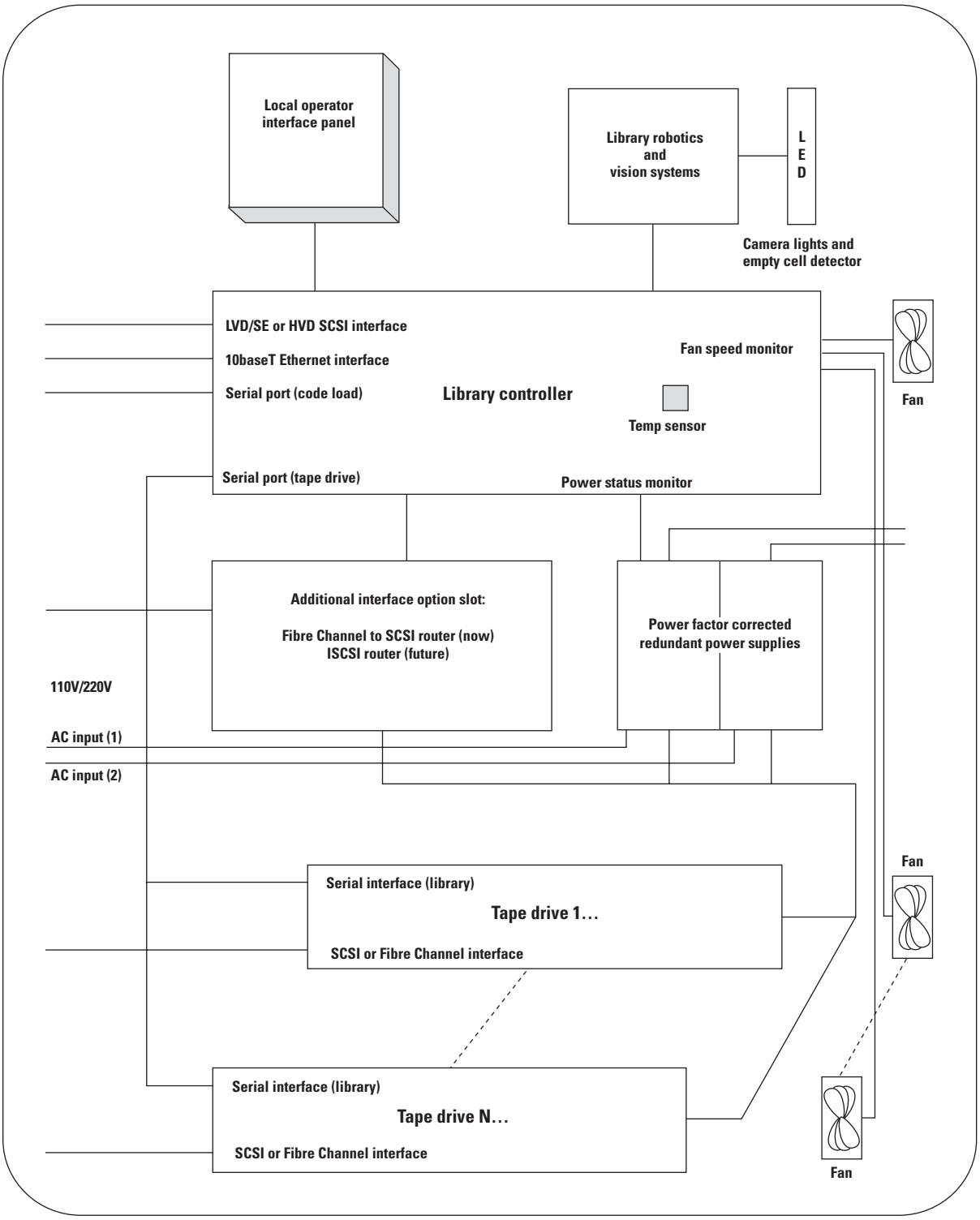

Figure 1. L20, L40 and L80 Electrical Diagram.

ABOUT STORAGETEK®

Storage Technology Corporation (NYSE: STK), a $2 billion worldwide company with headquarters in Louisville, CO, has been delivering a broad range of storage management solutions designed for IT professionals for over 30 years. StorageTek offers solutions that are easy to manage, integrate well with existing infrastructures and allow universal access to data across servers, media types and storage networks. StorageTek's practical and safe storage solutions for tape automation, disk storage systems and storage integration, coupled with a global services network, provide IT professionals with confidence and know-how to manage their entire storage management ecosystem today and in the future.

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