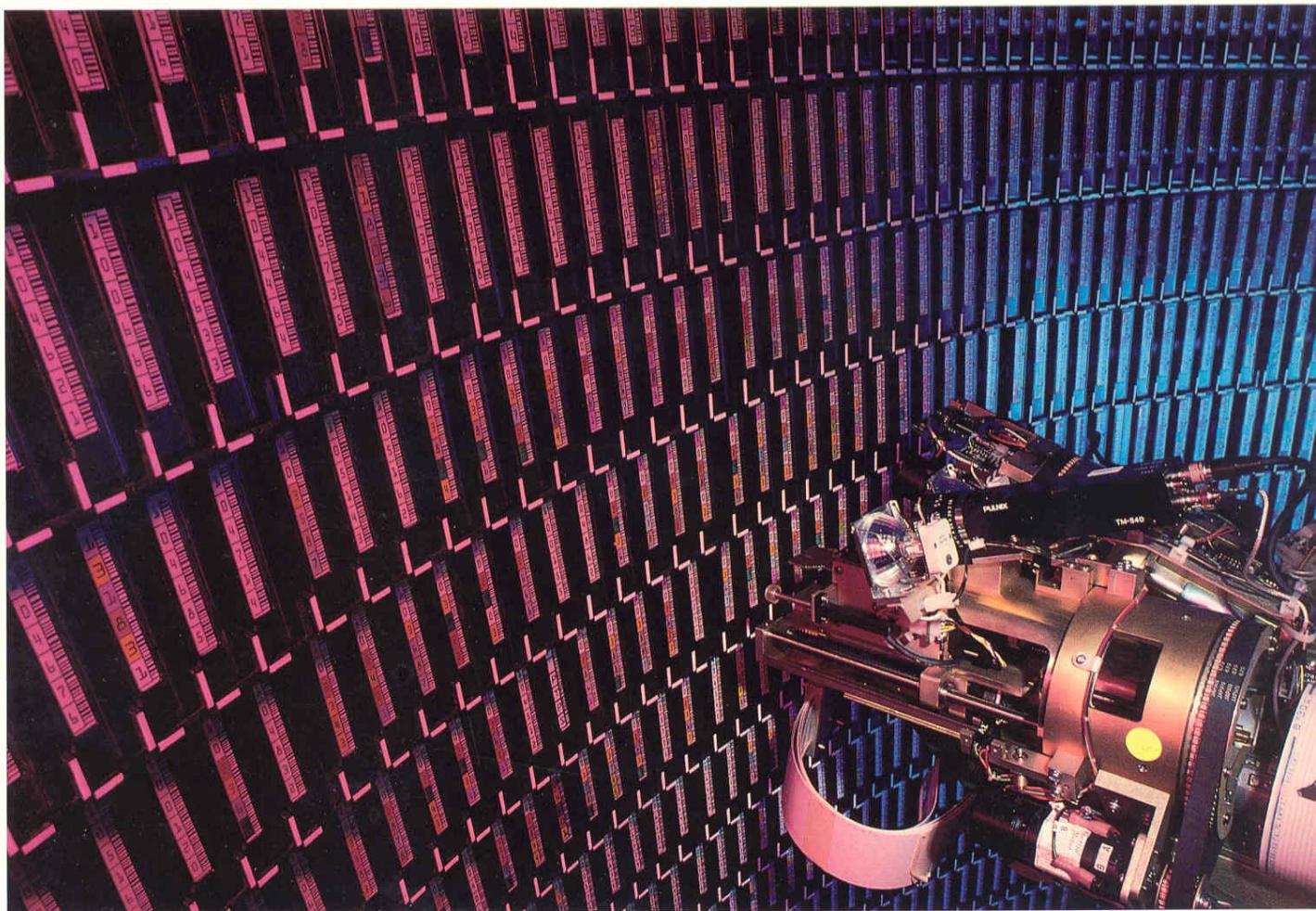


4400 Automated Cartridge System



General Information

The 4400 Automated Cartridge System (ACS) is a fully automated information storage system. It automatically mounts and demounts 18-track cartridges on the StorageTek® 4480 — a cartridge subsystem that is completely compatible with the IBM® 3480 manual-only subsystem.

Because the StorageTek system is automated, it not only boosts performance and cost efficiencies over manual tape systems, it also redefines the roles of conventional storage devices.

Data kept online can be retrieved very quickly, but at a cost that often prohibits many new applications. Data stored offline is considerably less expensive, but access requires more time. In addition, the cost of labor associated with manual tape makes this method of data storage too expensive for many new applications. Now the StorageTek 4400 Automated Cartridge System gives you a new choice and a new dimension in storage management: Nearline™.

A revolutionary technology unique to the 4400 Automated Cartridge System, nearline stores data at a fraction of the cost per megabyte of online storage. But its quick, consistent response time places the 4400 ACS much closer to DASD in performance. Nearline streamlines storage management in many ways.

- Large amounts of data are only seconds away. The advanced robotics in StorageTek's Automated Cartridge System retrieves and delivers cartridges in an average time of 11 seconds.
- With a footprint 30 percent to 70 percent smaller than that of comparable manual systems — and with labor costs reduced—the 4400 ACS stores data at less than \$.50 (U.S.) per megabyte purchased.
- The speed and efficiency of the 4400 ACS make it the logical choice for applications going far beyond the traditional tape processing of DASD dumps and interchange. In fact, many current DASD-oriented applications—those requiring quick rather than immediate initial service times — can be transferred to the 4400 ACS with up to a fortyfold cost reduction.

The 4400 ACS was designed with our customers in mind. StorageTek's proven commitment to tape performance and reliability has provided the 4400 ACS with unmatched security, redundancy and reliability. StorageTek customers also helped design the 4400 ACS — directing its design toward the solution of real-world problems. And with systems currently installed in customer locations worldwide, these design solutions have become a reality.

Product Overview

The 4400 Automated Cartridge System consists of four elements: a 4480 Cartridge Subsystem (control units and cartridge drives), one or more Library Storage Modules (LSMs) with attached Library Control Units (LCUs), a Library Management Unit (LMU) and a Host Software Component (HSC). The 4400 ACS is divided into two independent components—the data path and the library-control path. The 4480 Cartridge Subsystem represents the data path, and the remaining elements combine to provide the library-control path.

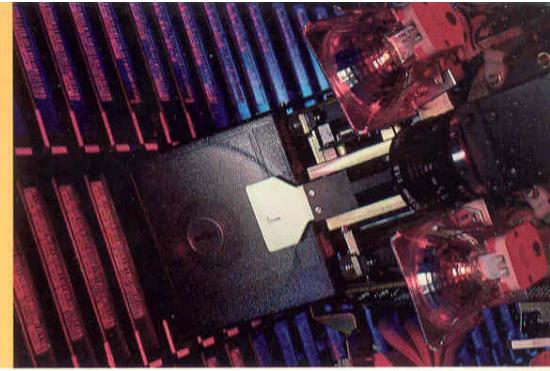
The 4480 Cartridge Subsystem The 4480 Cartridge Subsystem utilizes 18-track, 1/2-inch cartridges and is completely compatible with IBM's 3480 manually operated system—but that's where comparisons end. Extensive research and valuable customer input has led to the creation of a truly revolutionary subsystem.

Each 4480 control unit can access up to eight cartridge transports and a cross-coupled control feature allows two control units to access up to 16 cartridge transports. The unit features separate processors for channel and transport operations, a 4-megabyte buffer, digital circuitry plus the flexibility of operating up to 60 feet (18 meters) from the cartridge drive when attached to the 4400 ACS. The 4480 control unit can optionally be configured to support host data channels at speeds up to 4.5 MB/sec.

Each cartridge drive frame contains two or four transports, a fully digitized intelligent servo, a large easy-to-read message display, independent power supplies, automatic tape loading and StorageTek's proprietary thin-film heads. A unique feature, called the Velocity Option, improves the efficiency of transport operations by decreasing the nonproductive rewind and high-speed search functions by approximately 33 percent.

Both the control unit and cartridge drive offer continuously running self-diagnostics and remote diagnostic capability. And they are easily upgraded from manual to library mode to keep pace with your needs.

The Library Storage Module The Library Storage Module (LSM) is the key to nearline storage management. A 12-sided cylindrical structure



less than 8 feet (2.4 meters) tall and 11 feet (3.3 meters) in diameter, the LSM maximizes the efficiency of both horizontal and vertical floor space and is designed to house approximately 6,000 cartridges. At 200 megabytes per cartridge, each LSM represents approximately 1,200 gigabytes of storage.

The LSM is managed by an attached Library Control Unit (LCU). When it receives a request from the Library Management Unit, the micro-processor in the LCU commands the robot in the LSM to move to the storage cell or transport where the cartridge is to be moved or located, and to perform the proper operation. In the center of each LSM is a freestanding robotic assembly that retrieves, mounts and demounts the cartridges. Up to four cartridge drive frames (with a total of up to 16 transports) can be attached to the outside of the LSM. And up to 16 LSMs can be linked together by means of "pass-thru ports."

These allow the exchange of cartridges from one LSM to another when all transports are allocated on a particular LSM. This ensures that any cartridge can be moved to any available transport at any time—and that a limited number of transports can serve a large amount of stored data.

Within a 4400 ACS, cartridges move automatically, quickly and reliably. Inside each LSM, the robot "sees" the correct cartridge (by means of a solid-state camera and two lights mounted on each of the two hands) and "reads" the bar-code volume serial number (VOLSER) on the cartridge's external label. The robot then extracts the cartridge from its cell, moves it to a transport and mounts it. The robot mounts either 18-track data cartridges or tape-path cleaning cartridges, both stored within the LSM.

A cartridge-access port allows you to insert or eject up to 21 cartridges at a time per LSM without entering the LSM. Cartridges entered into the LSM



LMU

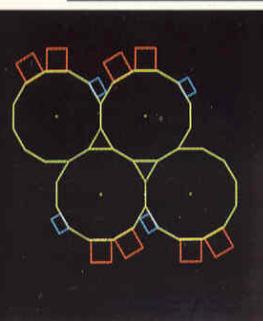
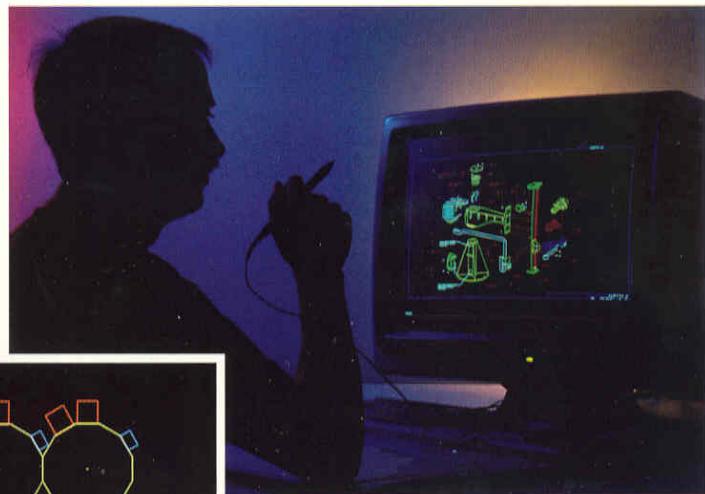
LCU

LSM

4480

4480

UP TO 4
MAXIMUM PER LSM



are then assigned a cell location. Or thousands of cartridges may be manually placed in an LSM at one time and the Host Software Component will "audit" the contents of the

LSM, updating its volume location directory.

The Library Management Unit

The Library Management Unit (LMU) manages up to 16 interconnected LSMs and can receive mount and demount requests from as many as 16 different hosts. When the LMU receives a request from a host to mount a cartridge, it selects the correct LSM. It sends messages to the LCU to instruct the robot to select the correct cartridge, validate the identification label, retrieve the cartridge and mount it in the drive. The LMU then returns status to the Host Software Component.

The Host Software Component The Host Software Component (HSC) provides the interface between the operating system running on a host and the library system. The HSC runs on any CPU that utilizes the IBM MVS/XA operating system (with either JES2 or JES3), the MVS/SP operating system with JES2 or the VM/SP operating system. It requires no modification to the operating system or the user's JCL. The MVS versions support any tape management system, but interface directly with the CA-1® and TLMS® products. The VM/SP version interfaces directly with the VMTAPE® tape management system as well as user-written systems.

The primary function of the HSC is to automate the mounting and demounting of cartridges. It enhances allocation, intercepts operator mount/demount messages and translates them into commands understood by the LSM's robotics—so that the correct cartridge can be located, removed from its cell, delivered to the nearest

available cartridge drive and replaced in its cell upon completion. To ensure system integrity and reliability, discrete paths enable the HSC to respond to console mount/demount messages independent of channel-to-drive communication. The HSC is capable of supporting a multi-CPU environment with up to 16 hosts sharing a single 4400 ACS library. It is designed to operate in a hybrid environment with both an automated library and manual transports—directing library-controlled cartridges to library drives and non-library cartridges to non-library drives. Up to 256 unique ACSs are supported by the HSC.

The HSC refers to a control dataset stored on a 3380-class DASD volume. This control dataset is shared by all hosts attached to the library and maintains information about host operation, library configuration, library work-in-progress, and location and status of all volumes within the library.

To further refine operation of the 4400 ACS and enhance operator control, the HSC provides a wide range of operator commands and utility functions. These enable the operator to start and stop operations of a particular host CPU; allocate and deallocate library resources; recover library resources in the event of a host failure; display status of all library components; locate a volume within the library; interface with the host tape management system to acquire scratch status information; redistribute scratch volumes; mount and demount cartridges from a drive; enter, initialize and eject cartridges from the library; and audit the physical contents of storage cells.

Operational Highlights

The 4400 Automated Cartridge System offers a level of cost/performance never before achieved in data storage. And its design reflects a commitment to long-term dependability and data security, making the system even more attractive.

System Reliability System reliability begins with extensive engineering (derating) of critical parts. The lead screw in the LSM, for example, is rated at 4,500 pounds (2,040 kg)—even though the system requires it to hold only 15 pounds (7 kg). The LMU is capable of handling twice the power it requires under maximum load.

To further ensure against system failure, the 4400 ACS incorporates redundant (or "duplicated") components, data paths and critical assemblies—such as the robot's two "hands"—and utilizes many components already proven in the space industry. Both the 4400 ACS as a whole and its components have been and continue to be subjected to extensive and rigorous testing.

But that's not all. Some of the system's components are "intelligent"—monitoring and correcting themselves without human intervention. For instance, the robotic mechanism is self-orienting and self-calibrating. It automatically compensates for any shifting of its environment over time, eliminating the need for field adjustments.

Data Availability Even if the automated function of the 4400 ACS should become inoperative, you still have access to your data and cartridge drives in the library. You can simply enter the LSM through

the door and mount your cartridges manually from the mount instructions directed to the transport's displays within the LSM. And if a transport should be out of service, the LSM has up to 15 others to keep your data accessible.

Data Security Data security is an inherent advantage of the 4400 Automated Cartridge System. The LSMs, secured by lock and key, are extremely effective as restricted-access enclosures for sensitive data. Automation also reduces traffic in the data center—and, thus, the possibility of unauthorized access.

Other security measures are designed in as well. Each time a cartridge is ejected from an LSM, and each time an LSM's door is opened, the event is logged automatically by time and date.

Optional halon systems, activated by smoke sensors inside the LSM, are also available from several halon manufacturers.

Specifications

PERFORMANCE

Tape Speed	79 ips (2 m/sec)
Rewind Time	48 sec (approximately) 32 sec (with Velocity Option)
Robotics Service Time (avg)*	11 sec
Channel Interfaces	Block Multiplex Byte Multiplex
Tape Loading	Fully Automatic
Tape Threading	Fully Automatic
Channel Protocol	D.C. Interlock Data Streaming
	1.5 MB/sec 3.0 MB/sec or 4.5 MB/sec
Transfer Rates	
Transport-to-Buffer	3.0 MB/sec
Channel-to-Buffer	3.0 MB/sec or 4.5 MB/sec

* Within one Library Storage Module.

CARTRIDGE DRIVE (CD)

Transports per Frame	2 or 4
Operation	60 Hz/50 Hz
Dimensions	(inches/centimeters)
Height	63.5/161.3
Width*	29.0/73.7
Depth	32.0/81.3
Weight	(pounds/kilograms)
	750/340 (4 transports)
	550/250 (2 transports)
Service Clearance	(inches/centimeters)
Front	None required
Rear	32/81

* With side panels.

CARTRIDGE SUBSYSTEM CONSTRUCTION

Data Buffer Size	4 MB
Read/Write Heads	StorageTek Thin-Film, 18-Track
Servo (Motion Control) Circuitry	Fully Digital
Floppy Disks	Double-Sided, Double Density

CARTRIDGE SPECIFICATIONS

Format	IBM 3480-compatible
Character Density	37,871 characters/in 1,491 characters/mm

CONTROL UNIT (CU)

Operation	60 Hz/50 Hz
Channel Attachments	1 Standard (Up to 7 more optional)
Dimensions	(inches/centimeters)
Height	63.5/161.3
Width*	29.0/73.7
Depth	32.0/81.3
Weight	(pounds/kilograms)
	350/158.8
Service Clearance	(inches/centimeters)
Front	32/81
Rear	32/81

* With side panels.

POWER REQUIREMENTS

FOR CARTRIDGE SUBSYSTEM

Power Consumption ²	CU	CD (4 transports)			CD (2 transports)		
		1 kVA	1.56 kVA	.85 kVA	.70 kW	1.4 kW	.75 kW
Line Current ^{2,3}		12.2A @ 180 VAC (200 VAC nominal)					
		6.8A @ 323 VAC (380 VAC nominal)					
Line Frequencies ²		Between 47 and 63 Hz			Wye		
Line Voltage		200	208	220	230	240	380 415
Tolerance		±10	+10, -15	+10, -15	+10, -15	+10, -15	+10, -15
Phases		3	3	3	3	3 ¹	3 ¹
Maximum Amps RMS ³		24	24	24	24	15	15
Heat Output ²		BTUs/hr	KCAL/hr			Power Connectors	
	CU	2,390	600			U.S./Canada	Russell Stoll 3760
	CD (4 transports)	4,780	1,200			Other	None
	CD (2 transports)	2,560	650				

¹3 phases plus neutral.

²These are operating values.

³For 1x8 cartridge subsystems (1 CU plus 2 CDs with 8 transports).

StorageTek

Specifications

LIBRARY STORAGE MODULE (LSM)

Operation	60 Hz/50 Hz	Weight	(pounds/kilograms)
Dimensions	(inches/centimeters)	Loaded	8,400/3,810
Height	92.5/234.9	Unloaded	5,400/2,449
Diameter *	128.0/325.0		

* Across the flats of the wall.

LIBRARY CONTROL UNIT (LCU)

Dimensions	(inches/centimeters)
Height	63.5/161.3
Width	15.6/39.7
Depth	22.5/57.2
Weight	(pounds/kilograms)
	300/136

LIBRARY MANAGEMENT UNIT (LMU)

Operation	60Hz/50 Hz
Host Attachments	1 Standard (Up to 15 more optional)
Dimensions	(inches/centimeters)
Height	42.0/106.7
Width *	29.0/73.7
Depth	32.0/81
Weight	(pounds/kilograms)
	250/113.3
Service Clearance	(inches/centimeters)
Front	32/81
Rear	32/81

* With side panels.

HOST SOFTWARE COMPONENT (HSC)

Supports IBM MVS/XA operating system.
Supports IBM VM/SP operating system.
Supports IBM MVS/SP operating system.

POWER REQUIREMENTS FOR LSM AND LCU

Line Voltage	200	208	220	230	240
Tolerance	± 10	+ 10 - 15	+ 10 - 15	± 10	+ 10, - 15
Phases	1	1	1	1	1
Maximum Amps RMS	12	12	12	12	12
Power Consumption*	1.1 KW	1.5 kVA			
Line Current*	8.4 A @ 180 VAC (200 VAC nominal)				
Line Frequencies*	Between 47 and 63 Hz				
Heat Output*	3,750 BTUs/hr	950 kCAL/hr			
Power Connectors	U.S./Canada	Russell Stoll 3720			
	Other	None			

* These are operating values.

POWER REQUIREMENTS FOR LIBRARY MANAGEMENT UNIT (LMU)

Line Voltage	200	208	220	230	240
Tolerance	± 10	+ 10 - 15	+ 10 - 15	± 10	+ 10, - 15
Phases	1	1	1	1	1
Maximum Amps RMS	8	8	8	8	8
Power Consumption*	.6 KW .88 kVA				
Line Current*	4 A @ 180 VAC (200 VAC nominal)				
Line Frequencies*	Between 47 and 63 Hz				
Heat Output*	2,050 BTUs/hr 515 kCAL/hr				
Power Connectors	U.S./Canada	Russell Stoll 3720			
	Other	None			

* These are operating values.

ENVIRONMENTAL SPECIFICATIONS

Temperature	Operating 60–90° F (16–32° C)	Storage 40–90° F (4.4–32° C)	Shipping –23 + 120° F (–10 + 48° C)
Thermal Change	≤ 9° F per hour (≤ 5° C per hour)	≤ 27° F per hour (≤ 15° C per hour)	≤ 27° F per hour (≤ 15° C per hour)
Humidity	20–80%	10–90%	5–100%
Wet Bulb Maximum	78° F (25.6° C)	80° F (26.7° C) (noncondensing)	80° F (26.7° C) (noncondensing)
Altitude	0–10,000 feet (0–3,050 meters)	0–10,000 feet (0–3,050 meters)	0–50,000 feet (0–15,240 meters)

NOTE: The shipping environment must not exceed the limits of the storage environment for a period longer than 10 days.

CONFIGURATIONS AND CAPACITIES

Channels per CU (max)*	Hosts per LMU (max)	16
Individual	8	
Subsystem	16	
Transports per CU (max)	LSMs per LMU (max)	16
Individual	8	
Cross-Coupled	8	
Subsystem	16	
Transports per CU	CDs per LSM	1 minimum 4 maximum
2 or 4		
CDs per CU (max)	Transports per LSM	2 minimum 16 maximum
Individual	4	
Cross-Coupled	4	
Subsystem	8	

* Channels 1-4 now available, channels 5-8 available 3Q 1989.

Specifications/features may change without notice.

World Headquarters/US Operations
Storage Technology Corporation
Product Marketing Department
2270 South 88th Street
Louisville, Colorado 80028-4358 USA
Phone: (303) 673-4063
Telex: 3720475 TWX 3103720475

EO083-1 09/88 Printed in USA. © Copyright 1988 Storage Technology Corporation, Louisville, CO. All Rights Reserved. VMTAPE® is a registered trademark of VM Software, Inc. StorageTek® is a registered trademark of Storage Technology Corporation. IBM® is a registered trademark of International Business Machines. Nearline™ is a trademark of Storage Technology Corporation. CA-1® and TLMS® are registered trademarks of Computer Associates International, Inc.

Europe/Middle East/Africa Operations
Storage Technology (Europe) Limited
Churston House, Portsmouth Road
Esher, Surrey
KT10 9AD, United Kingdom
Phone: 44 372 69121
Telex: (851) 918076

Canada Operations
StorageTek Canada, Inc.
51 International Boulevard
Rexdale, Ontario
Canada M9W 6H3
Phone: (416) 675-3350
Telex: 063666 TO 21:XSC001

Pacific and Latin America Operations
Storage Technology Corporation
Pacific and Latin America Operations
2270 South 88th Street
Louisville, Colorado 80028-4364 USA
Phone: (303) 673-5979
Telex: 3720475 TWX 3103720475



StorageTek: The
information storage
and retrieval company.