4mm DDS-3 Tape Drive and Autoloader

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Introduction

The Sun™ 12–24-GB, 4mm DDS-3 tape drive and the 72-144-GB autoloader is Sun's latest 4mm DAT offering which provides improved performance, capacity, and reliability while maintaining compatibility with older DDS formats. The 4mm DDS-3 tape drive is ideal for such critical applications as workstation backup and archive, and data distribution and interchange, while the autoloader is the ideal solution for backup and archive of mid-size workgroups and small departmental servers. The 4mm DDS-3 tape drive and autoloader are compatible with the majority of Sun servers and workstations, including the Ultra™ Enterprise™ family of servers.

The new 12–24-GB, 4mm DDS-3 tape drive will augment Sun's 4mm tape drive product line, co-existing with the current 4–8-GB, 4mm DDS-2 tape drive. The Sun 72–144-GB, 4mm DDS-3 autoloader replaces the existing 16–32-GB, 4mm DDS-2 autoloader.

4mm DDS-3 Tape Drive

4mm DDS-3 Autoloader

Figure 1. The DDS-3 Tape Drive and Autoloader

Introduction *(cont.)*

With triple its predecessor's native capacity at 12-GB, the 4mm DDS-3 tape drive offers superior capability as a workstation backup solution while maintaining backward read/write compatibility with DDS-2, DDS-1, and DDS-DC formats. The 72–144-GB, 4mm DDS-3 autoloader can hold up to 6 tape cartridges and has a native capacity 4.5 times larger than the DDS-2 autoloader.

Key Messages

- 12-GB native capacity on DDS-3 tape drive using standard 125 meter DDS-3 media
- 72-GB native capacity on DDS-3 Autoloader using standard 125 meter DDS-3 media
- 1-MB/sec native data transfer rate
- Built-in data compression increases native transfer rate to 2-MB/sec and capacity specifications to 24-GB (typical) for the tape drive and 144-GB (typical) for the autoloader
- Backward read/write compatible with DDS-2, DDS-1, and DDS-DC formats, with Media Recognition System (MRS) capability to automatically adjust to the correct tape format
- Robust, highly reliable, low cost mechanism
- Meets all domestic and international regulations for safety and emissions
- Standard SCSI-2 interface with active termination
- 3.5" standard drive form factor

Availability

- The 4mm DDS-3 tape drive begins shipping on December 9, 1996.
- The 4mm DDS-3 autoloader begins shipping on December 23, 1996.

4mm DDS-3 Tape Drive and Autoloader *(cont.)*

Target Users

There are multiple types of users who would be interested in the key features and benefits of this new 4mm DDS-3 Tape offering:

- Customers with mid-sized workgroup servers or small departmental servers looking for an excellent price/performance backup and archive solution
- Customers needing large capacity add-on storage and high-performance on the desktop or configured into workgroup or departmental servers
- Users interested in local backup and archive of their workstation(s)
- Companies needing a reliable, compact method of data distribution and interchange
- Sun installed base customers requiring additional storage and interested in staying with their current investment in 4mm technology.

Key Features and Benefits

• **Features**	• **Benefits**
– 1-MB/sec native data transfer rate; – 2-MB/sec compressed	– Customers can backup up to 57.6-GB in an 8 hour window
– Built-in data compression	– Doubles capacity and transfer rate, requires less tape swapping
– Less expensive than 8 mm tape	– Low cost backup solution
– Backward compatibility	– Capable of restoring old archived data, and ideal for data interchange
– 300,000 hours MTBF at 12 percent duty cycle and covered by 3-year warranty	– Improved reliability
– Every drive rigorously tested on Sun Systems	– Ensures optimal performance and quality

Target Markets

The Sun 12–24-GB, 4mm DDS-3 tape drive and 72–144-GB, 4mm DDS-3 autoloader are excellent solutions for backup, archive, data distribution, and interchange for companies in any industry. Based on a particular market, you can highlight different features.

Industry	Key Features to Highlight
• Financial – Stock and commodity traders – Banks	Small desktop footprint for data backup and archive High capacity autoloader to backup data for mid-sized workgroup, small departmental, and network servers
• Government – Civilian agencies – Military	Satisfies multiple environmental, safety and regulatory specifications High capacity autoloader to backup data for mid-sized workgroup or small departmental servers
• Health – Hospitals – Doctor's office – Drug companies	Small desktop footprint for data backup and archive High capacity autoloader to backup data for mid-sized workgroup, small departmental, and network servers
• Publishing – Newspapers – Magazines – Television newsrooms – Advertising agencies	High capacity autoloader to backup data for mid-sized workgroup, small departmental, and network servers
• Engineering/scientific companies – Maintenance operations – Design center – Operations center	Small desktop footprint for data backup and archive Reliable, compact method for data distribution and interchange High capacity autoloader to backup data for mid-sized workgroup, small departmental, and network servers

Key Applications

The DDS-3 drive does not require any specific application software. Solaris™ commands (for example, "tar" and "dump"), will work the same as for existing DDS-1 and DDS-2 drives.

The DDS-3 autoloader is capable of functioning in either sequential (Stacker) or random-access (Random) mode. No specific software package is required, but to use the more advanced features of the autoloader (Random mode), a storage management application like Solstice™ Backup™ will be required.

Solstice Backup 4.2, and most other backup applications will support both the DDS-3 tape drive and autoloader.

Product Family Placement

The new 12–24-GB, 4mm DDS-3 tape drive augments Sun’s 4mm tape drive product line, co-existing with the current 4–8-GB, DDS-2 tape drive. The 72–144-GB, 4mm DDS-3 autoloader replaces the existing 16–32-GB, 4mm DDS-2 autoloader except for the current external options which will remain a DDS-2 autoloader offering.

The 4mm DDS-3 tape drive and autoloader are well positioned for:

- Workstation backup and archive
- Network/server backup and archive
- Data interchange/distribution/acquisition

In regards to Sun’s tape product line, this is a small-to-mid range solution for tape backup, whereas 8 mm and DLT™ products offer a higher-end solution. It is a more mid-size solution than DDS-2 tape offerings which offer very good entry-level backup solutions. The price/performance ratio for a DDS-3 tape drive enables a lower total cost-of-ownership since it has a price/performance cost that is 25 percent that of DDS-2 tape drives. DLT and 8 mm products offer an even lower price/performance cost, but the initial unit cost of these products demonstrates that they are a higher-end solution.

4mm DDS-3 Architecture

Tape Technology Overview

Using tape technology, data is stored by moving a tape across a recording head and converting the data stream into small magnetic domains on the tape. These domains are stored along a track. To read the information, the recording head follows the track and recovers the stored information. Tape capacity is determined by the width and length of the tape, the linear density of the magnetic domains and the number of tracks on the tape.

There are two basic implementations of tape recording technology, linear and helical scan. We'll discuss both technologies in this document, although the helical scan is used in 4mm tape technology.

Linear Tape Technology

Linear tape drive technology records data in long parallel tracks that run the length of the media. It does this with fixed read/write head and very fast moving tape. The number of recording elements on the head determines how many tracks can be written on the tape. For example, the recording head on a 3490E tape drive has 18 recording heads. A total of 36 tracks are written by making two passes of the tape over the fixed head. In the tape industry, the process of moving the tape across the heads multiple times is known as *serpentine* recording.

The drive mechanism for linear tape technology is very simple with few moving parts. The original implementation of linear tape technology was a reel-to-reel drive format where tapes were threaded onto open reels. Later, a cartridge format was developed where the tape reels and drive mechanism were self contained in a sturdy cartridge. Since the heads are fixed in linear recording technology, they are inherently very reliable with quoted MTBFs of over 100,000 passes.

The complexity of this technology resides in the constructions of the coated tape media. Different media formulations allow different linear recording densities. Recent development of Metal Particle (MP++) media doubles the recording density over Chromium Oxide (CrO_2) coated materials which are the most common in the industry. Another new method of coating tapes called Metal Evaporate (ME) also provides very high recording densities.

Helical Scan Technology

Instead of creating tracks parallel to the tape edge, helical scan technology records data on relatively slow moving tape in narrow tracks that run diagonally across the tape. A single track is written by a rotating read/write head in contact with the media with an axis of rotation at five to six degrees from the perpendicular. Contact is made by wrapping the tape partially around the rotating recording head.

This technique was developed for use in video recording but engineers discovered that it enabled much higher image density to be written on 4mm and 8mm tape at faster rate of speed than linear recording technology.

The complexity of helical scan recording technology lies in the construction of the drive. By wrapping the tape around a rotating head, both the tape and the head are gradually worn after repeated passes. The tape cartridge is very simple and much less rugged than linear tape cartridges.

4mm DDS-3 Architecture *(cont.)*

4mm Tape Technology

The 4mm tape technology was originally developed by Philips Consumer Electronics as a digital audio format for the consumer market. Also known as DAT (Digital Audio Tape), 4mm tape drives have two heads for reading and two for writing. The tape wraps 90 degrees around the drum's circumference and the heads move in a spiral motion from the bottom to the top of the tape. This method permits much higher recording density than streaming tape methods because magnetic interference between tracks is reduced and tracks can be positioned more precisely.

The standards for recording using DAT devices are called Digital Data Storage (DDS). They include

- DDS (or DDS-1)

  DDS is a modification of the DAT technology that constructs a sequence of fixed-capacity groups on the tape. The basic DDS format allows data to be written sequentially, appending data to the existing information, and to be read randomly beginning at any point. DDS tapes can store up to 2-GB of data on 90 meter tape.

- DDS-2

  DDS-2 was developed to allow for higher density recording. DDS-2 doubles the density of DDS but maintains full DDS functionality and is backwards compatible. It has a native capacity of 4-GB on 120 meter tape.

- DDS-DC

  DDS-DC is similar to DDS-2 but includes a data compression standard that enables up to 8-GB per tape. It allows uncompressed data to be stored in a way that maintains full DDS functionality and ensures backward compatibility with existing DDS drives. However, older drives that do not include the data compression algorithm cannot read this format.

- DDS-3

  DDS-3, a new implementation of helical scan technology, will offer three times the capacity and double the data transfer rate of current DDS-2 drives. It offers a native capacity of 12-GB with a transfer rate of 1-MB/sec.

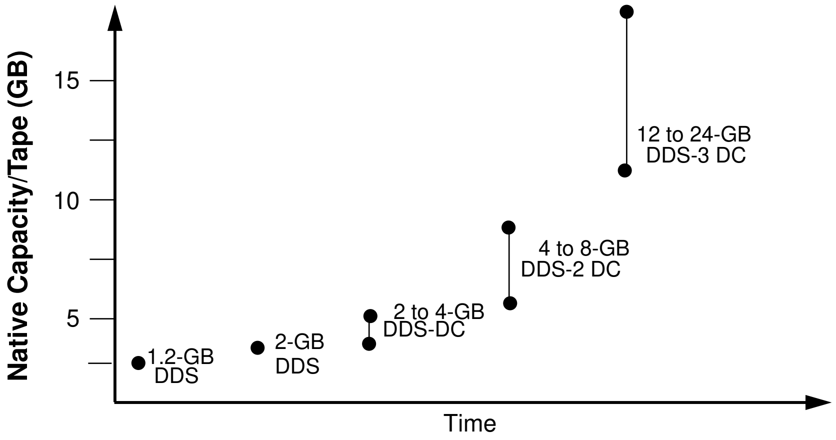

Figure 1. The Evolution of 4mm Tape Capacities

4mm Tape Technology *(cont.)*

4mm drives are packaged in a small cartridge that fits into a 3.5-inch wide drive. 4mm DDS-2 tape drives have a 4-GB native capacity using standard 120 meter DDS-2 media and a transfer rate of 400-KB/sec. The popularity of the 4mm format can be attributed largely to its ability to be incorporated into 3.5-inch packaging, its multiple sources of supply, and the lower costs of the mechanism compared to 8mm or other alternatives.

4mm tape has well-defined manufacturing standards. A DDS manufacturing group has been established that defines industry standards for format and production. As a result there are multiple sources of supply for 4mm tape drives and 4mm media.

Robotic systems offering multiple tape capacity are also available for this tape format. With the capacity to store several gigabytes of data at a low cost, 4mm tape backup systems offer an excellent backup solution for workgroup environments.

Sun’s newest 4mm products is are 4mm helical scan DDS-3 tape devices operating on the industry standard SCSI-2 interface and fitting within the 5-1/4” half-height form factor (3.5” drive with 5-1/4” bracket). Digital Data Storage 3 (DDS-3) is a follow-on of DDS-1 and DDS-2 DAT drive. This device provides a sustained transfer rate of 1-MB/sec (uncompressed data). The device is capable of reading and writing 60 meter, 90 meter, 120 meter, and 125 meter DDS data tapes. The capacity of DDS-3 is typically 12-GB native and 24-GB compressed on a DDS-3, 125 meter cartridge.

4mm DDS-3 Architecture *(cont.)*

Tech Facts

Compression (2:1 ratio) is an ‘average’. Different types of data compress at different rates. Some data hardly compresses at all, while some compresses at greater than the 2:1 ratio.

Performance Specifications	DDS-3 Tape Drive	DDS-3 Autoloader
Compression	DCLZ	DCLZ
Capacity (native)	12-GB per 125m DDS-3 tape	72-GB with 125m DDS-3 tapes
Number of tapes	1	6 tapes per magazine
Sustained transfer rate	1-MB/sec native	same
Burst rate (synchronous/asynchronous)	10-MB/sec (synch.) 3-MB/sec (asynch.)	same
Error rate	<1 in 10e15	same
Buffer	2-MB	same
Interface	Single-ended SCSI-2	same
MTBF	300,000 hours (12 percent duty cycle)	55,000 hours (18 percent duty cycle)
Cartridge swaps	N/A	> 100,000
Tape Speed	0.41 in/sec	same
Average file access time	40sec on 125m cartridge	same

Duty Cycle: Amount of time the drive mechanism is active as a percentage of clock time.

4mm DDS-3 Architecture *(cont.)*

Physical Specifications

Characteristic	DDS-3 Tape Drive	DDS-3 Autoloader
Size	3.5” form factor, half-height	5.25” form factor, full-height
Height	41.3 mm (1.6 in.)	82 mm (3.2 in.)
Width	101.6 mm (4.0 in.)	146 mm (5.7 in.)
Depth	150 mm (5.9 in.)	203 mm (8.0 in.)
Weight	1.0 kg (2.2 lbs)	N/A

Electrical Specifications

DDS-3 Tape Drive

Condition	DC Voltage	
	+5VDC +/-5%	**+12VDC +/-10%**
Initial power up maximum peak	0.95A	0.51A
Operation current	0.95A	0.06A
Noise plus ripple (max.)	<100mV Peak-Peak	<150mV Peak-Peak
Power dissipation (operating)	6W	
Power dissipation (max.)	10.2W	

DDS-3 Autoloader

Condition	DC Voltage	
	+5VDC +/-5%	**+12VDC +/-10%**
Initial power up maximum peak	1.2A	0.8A
Operation current	<1.2A	0.25A
Noise plus ripple (max.)	<100mV Peak-Peak	<150mV Peak-Peak
Power dissipation (operating)	9W	
Power dissipation (max.)	15.6W	

Environment Specifications

	Operating	Non-Operating
Temperature range **Gradient**	5 to 40^{o}C <10^{o}C/hour	-40 to +70^{o}C <20^{o}C/hour
Humidity range **Wet Bulb, maximum gradient**	20% to 80% RH, non-condensing 26^{o}C <30%/hour	5% to 95% RH <30%/hour
Altitude range	0 to 4,600 meters (0-15,000 ft.)	0 to 15,200 meters (0-50,000 ft.)
Vibration	Swept Sine: 0.3g peak, 5-500-Hz @ 1 octave/min Random: 5–350-Hz @ 0.00053g^2/Hz 350–500-Hz @ -6dB/octave 500–Hz @ 0.00027 g^2/Hz	Swept Sine: 0.75g Peak, 5-500-Hz @ 1 octave/min Random: 5–100-Hz @ 0.02 g^2/Hz 100–137-Hz @ -6dB/octave 137–350-Hz @ 0.0107 g^2/Hz 350–500-Hz @ -6dB/octave 500-Hz @ 0.0052 g^2/Hz
ESD Immunity (Front Panel only)	0–10 kV air discharge (No performance change) 0–25 kV air discharge (Hardware survival)	N/A
Shock (1/2 sine wave)	8g’s peak, 11 ms	90g’s peak, 3 ms
Acoustical noise **Idle** **Operating, typical**	 45 dBA maximum 50 dBA maximum	N/A

Applicable Documents

Environmental

950-1653-01	Electrical and Immunity Test Specification

Interface

ANSI X3T9.2/375R	Small Computer Systems Interface-2, SCSI-2 Rev. 10k

Reliability and Quality

MIL-STD-217E	Military Handbook: Reliability Prediction of Electronic Equipment
MIL-STD-781	Military Handbook: Reliability Test Procedures
910-2953-01	Design Guideline: Component Derating and Smoke Emission,Revision C

Safety

UL 1950	Standard for Safety: Information Technology Equipment, Including Electrical Business Equipment
CAN/CSA-C22.2,	Safety of Information Technology Equipment, Including Electrical Business Equipment
CSA No. 950-M89	
DIN/VDE 0805	Safety for Business machines
EN 60 950	European Community Regulations for Safety of Information Technology Equipment Including Electrical Business Equipment
TUV	Component Mark

Applicable Documents *(cont.)*

Regulatory

VCCI (= CISPR 22)	Japanese Voluntary Council for the Control of Interference Regulations
EN 55022 (=CISPR 22)	Specification for Limits and Methods of Measurement of Radio Interference Characteristics of Information Technology Equipment
EN 60 555-2 (IEC 55-2)	Disturbances in Supply Systems Caused by Household Appliances and Similar Equipment - Specification for Harmonics
CSA C108.8	Electromagnetic Emissions from Data Processing Equipment and Electronic Office Machines
FCC CFR 47	FCC Rules for Computing Devices Part 15, Subpart B
FCC MP-4	Procedure for Measuring RF Emissions from Computing Devices.
FCC OST 55	Characteristics of Open Field Test Sites
VFG243/1991	Regulation for Radio Frequency Interference

Acoustical

ISO Standard 3744	Engineering Methods for Free Field Conditions Over a Reflecting Plane
ANSI S12.10-1985	Methods for Measurement and Designation of Noise Emitted by Computer and Business Equipment, Appendices A and B

Software Requirements

Modifying Configuration Files

For optimum performance on systems running Solaris™ releases 2.4, 2.5 and 2.5.1, you must modify the `st.conf` file. For the Solaris 1.1.2 operating environment, you must modify the `st.conf` and `stdef.h` files. Please refer to one of the following documents for information on how to modify these files:

- *72-144 Gbyte DDS-3 Autoloader Installation and User's Guide* (Sun part number 802-7901-10)
- *12-24 Gbyte 4mm DDS-3 Tape Drive Installation and User's Guide* (Sun part number 802-7791-10)

The Sun 4mm DDS-3 tape drive and autoloader are supported on Solaris 1.1.2 or Solaris 2.4 operating environment and later releases. In order to address SCSI ID 8 and above, a wide host bus adapter (like the SWIS/S) is required.

Solstice™ Backup™ 4.2, and most other backup applications will support both the DDS-3 tape drive and autoloader.

When installed with the SWIS/S bus adapter, Solaris 2.4 or later releases are required and require patches. When installed with SunSwift™ host bus adapter, Solaris 2.5 or later releases are required.

For additional information on software commands please see the Solaris Handbook for SMCC Peripherals for your particular operating system.

System Configuration

Systems Supported

The 4mm DDS-3 tape drive and autoloader are supported on the following systems:

- SPARCstation™ 4
- SPARCstation 5
- SPARCstation 10
- SPARCstation 20
- SPARCserver 1000
- Ultra™ 1
- Ultra 2
- Netra™ i4, Netra j4
- Netra i5
- Netra i1, Netra j1
- Netra j2
- Netra j4000
- Netra j5000
- Ultra™ Enterprise™ 150
- Netra i 150
- Ultra Enterprise 3000 Server
- Ultra Enterprise 4000 Server
- Ultra Enterprise 5000 Server
- Ultra Enterprise 6000 Server

System Configuration *(cont.)*

Drive Options

- External drive options (UniPack)
  - A UniPack option for the 4mm DDS-3 tape drive is available for the SPARCstation 4, 5, 10, and 20, the SPARCserver 1000, and any of the Ultra workstation or Enterprise systems. It comes in two configurations
    - 68-pin to 68-pin SCSI cable,
    - 50-pin to 68-pin SCSI cable
- Internal drive option for Ultra 1 and Ultra 2
  - Internal drive with Sun light-grey bezel
- Internal drive option for Ultra Enterprise servers
  - An internal drive with Sun charcoal bezel

Autoloader Options

- Internal autoloader options for Ultra Enterprise 5000 and 6000 Systems
  - An internal autoloader option for the system or expansion rack with Sun charcoal bezel
  - An internal autoloader option with multi-tape backup tray for the system or expansion rack with Sun charcoal bezel

Ordering Information

4mm DDS-3 Tape Drive & Autoloader Marketing Part Numbers

Part Number	Option Description	Maximum Number Supported
X6280A	12–24-GB, 4mm tape SPARCstorage™ UniPack with 68-68 pin SCSI cable	10
X6281A	12–24-GB, 4mm tape SPARCstorage UniPack with 68-50 pin SCSI cable	10
X6282A	12–24-GB, 4mm tape drive, internal option for Ultra™ 1, 2	1
X6283A	12–24-GB, 4mm tape drive, internal option for Enterprise 3000, 4000, 5000, and 6000	1
X6286A	12–24-GB, 4mm tape drive, internal option for Ultra™ Enterprise™ 150	1
X6292A	72–144-GB, 4mm autoloader, internal option w/tray for Ultra Enterprise 3000, 4000, 5000, and 6000	4
X6293A	72–144-GB, 4mm autoloader, internal option for tray in Ultra Enterprise 3000, 4000, 5000, and 6000	4

Configuration Guidelines

- The 4mm DDS-3 tape drive and autoloader can also support previous generation 4mm tape media like DDS-2, DDS-1, and DDS-DC.
- The 72–144-GB, 4mm DDS-3 autoloader can support up to 6 tape cartridges in any DDS media format due to the Media Recognition System (MRS).
- The 50-[in to 68-pin cables are required when chaining the DDS-3 tape drive or autoloader to a narrow on-board host adapter or another external 50-pin connector device (i.e. Desktop Storage Module tape drive).

SunSpectrum℠ System Support Program

SunSpectrum℠ is an innovative and flexible service offering that allows customers to choose the level of service best suited to their needs — ranging from mission-critical support for maximum solution availability to backup assistance for self-support customers. SunSpectrum provides a simple pricing structure in which a single fee covers support for an entire system, including related hardware and peripherals, the Solaris™ operating system software, and telephone support for Sun™ software packages. The majority of Sun's customers today take advantage of the SunSpectrum program, underscoring the value it represents. Customers should check with their local SunService™ representative for program/feature variance and availability in their area.

FEATURE	**PLATINUM** Mission-Critical Support	**GOLD** Business-Critical Support	**SILVER** Systems Support	**BRONZE** Self Support
Systems Features				
Systems approach coverage	Yes	Yes	Yes	Yes
System availability guarantee	Customized	No	No	No
Account Support Features				
Service account management team	Yes	No	No	No
Personal technical account support	Yes	Yes	No	No
Account support plan	Yes	Yes	No	No
Software release planning	Yes	No	No	No
On-site account reviews	Monthly	Semi-annual	No	No
Site activity log	Yes	Yes	No	No
Coverage / Response Time				
Standard telephone coverage hours	7 x 24	7 x 24	8–8, M–F	8–5, M–F
Standard on-site coverage hours	7 x 24	8–8, M–F	8–5, M–F	N/A
7 day, 24 hour telephone coverage	Yes	Yes	Option	No
7 day, 24 hour on-site coverage	Yes	Option	Option	N/A
Customer-defined priority setting	Yes	Yes	Yes	No
– Urgent (phone/on-site)	Live transfer/2 hour	Live transfer/4 hour	Live transfer/4 hour	4 hour/NA
– Serious (phone/on-site)	Live transfer/4 hour	2 hour/next day	2 hour/next day	4 hour/NA
– Not critical (phone/on-site)	Live transfer/ customer convenience	4 hour/customer convenience	4 hour/customer convenience	4 hour/NA
Additional contacts	Option	Option	Option	Option

SunSpectrum System Support Program *(cont.)*

FEATURE	**PLATINUM** Mission-Critical Support	**GOLD** Business-Critical Support	**SILVER** Systems Support	**BRONZE** Self Support
Enhanced Support Features				
Mission-critical support team	Yes	Yes	No	No
Sun Vendor Integration Program (SunVIP™)	Yes	Yes	No	No
Software patch management assistance	Yes	No	No	No
Field change order (FCO) management assistance	Yes	No	No	No
Remote Systems Diagnostics				
Remote dial-in analysis	Yes	Yes	Yes	Yes
Remote systems monitoring	Yes	Yes	No	No
Remote predictive failure reporting	Yes	Yes	No	No
Software Enhancements and Maintenance Releases				
Solaris enhancement releases	Yes	Yes	Yes	Yes
Patches and maintenance releases	Yes	Yes	Yes	Yes
Sun unbundled software enhancements	Option	Option	Option	Option
Internet and CD-ROM Support Tools				
SunSolve™ license	Yes	Yes	Yes	Yes
SunSolve EarlyNotifier℠ service	Yes	Yes	Yes	Yes

Glossary

ANSI	American National Standards Institute, which sets standards for SCSI and the safety of electrical devices, amongst other things.
asynchronous	*See* data transfer
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 from the host computer.
autoloader	A device embodying a tape drive and a cartridge changer mechanism, housed in a single case.
block	A logical unit of information. Called “record” in the DDS-format specification.
C3 ECC	A third level of error correction code covered by the DDS format. C3 allows any two tracks in a group to be corrected, and is used only when a raw data error is too big to be corrected by C1 and C2. C3 code is stored in an extra frame at the end of the twenty-two frames of data in each group.
changer	A mechanism within an autoloader for moving tape cartridges from the magazine into the tape drive, and back again. *See also* random mode, stacker mode
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 done by representing strings of bytes with codewords.
DAT	Digital Audio Tape
data randomizer	*see* randomizing
data transfer phase	On a SCSI bus, devices put in requests to be able to transfer information. Once a device is granted its request, it and the target to which it wants to send information can transfer the data using one of two protocols (assuming both devices support them): asynchronous or synchronous In *asynchronous* transfers, the target controls the flow of data. The initiator can only send data when the target has acknowledged receipt of the previous packet. All SCSI devices must support asynchronous transfer. In *synchronous* data transfer, the initiator and target work in synchronization, allowing transmission of a packet of data to start before acknowledgment of the previous transmission. Sun DDS drives support asynchronous and synchronous transfers.

DCLZ	Data Compression Lempel-Ziv. A compression algorithm based on the Lempel-Ziv LZ2/LZW algorithms, but with improved performance.
DDS	Digital Data Storage is a recording format that builds on the DAT format to support the storage of computer data. It was developed originally by Hewlett-Packard and Sony as an industry standard. The first generation standard was DDS-1 (or simply DDS), to which was added data compression to produce the DDS-DC standard. Further enhancements, notably narrower tracks and thinner tape, led to DDS-2, which can typically provide double the capacity of DDS-1. DDS-3 uses a new magnetic coating on the tape that allows twice the recording density. Together with the use of time-tracking, this gives a DDS-3 tape approximately three times the capacity of a DDS-2 tape.
differential	*See* single-ended
ECC	Error Correction Code. *See* C3 ECC
Fast-SCSI	Data transfer rate of 10-MB/sec
Fast/wide-SCSI	Data transfer rate of 20-MB/sec. Wide devices can be connected to a narrow SCSI interface but the extra data lines need to be terminated.
forced ejection	In an emergency, you can force the drive to eject a cartridge. In doing so, data will probably be lost, and the tape may become unusable, so *be very cautious about using this emergency procedure*. To force the ejection of a cartridge, press the Unload button (the Eject button) three times within a 5-minute period, or hold it down for at least 5 seconds.
FRU	Field Replaceable Unit, an assembly or group of components that is replaced in its entirety by Service Engineers when it contains a fault.
GB	A disk GB is 1 billion (1,000,000,000) bytes. A memory GB is 1,073,741,824 bytes (2 to the 30th power).
host	The host computer system acting as controller for the drive.
Host adapter	A device that connects a peripheral device I/O protocol and medium to the computer system's I/O bus.

Media Recognition System (MRS)	A method by which a drive can recognize data-grade tape. The tape has a series of stripes on its transparent leader tape that the drive can detect. By default, the drive treats a non-Media Recognition System tape as read-only and will not write data to it. However, it is possible to switch the recognition system off using the Configuration switches on the underside of the drive. If this is done, the drive will treat all DDS tapes the same.
MTBF	Mean time between failures. A measure of reliability, this is the average expected time between failures of equipment, usually measured in operating hours.
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.
partition	A part of a tape that can be treated as a complete and independent whole. A tape can have one or two partitions.
PRML	Partial Response Maximum Likelihood—a method of recovering data from a signal that can cope with the higher density of data used by the DDS-3 format (a linear density of 122,000 bits per inch, which is twice that of DDS-1 and DDS-2). The technique not only identifies data bits more accurately, but by scanning the bits surrounding a bit being read, it can deduce the correct value for dubious bits.
random mode	*Autoloaders only:* In Random mode, cartridges are used in order dictated by the host or the user, rather than sequentially, as in Stacker mode. For each cartridge to be used, the host must issue a SCSI `MOVE MEDIUM` command to instruct the autoloader to move the cartridge from the magazine to the drive. When the cartridge is full, or when no further use is to be made of it, the host must again use the `MOVE MEDIUM` command to load another. Random mode is sometimes referred to as Changer mode.
IOPS	Input/output operations per second. A measure of I/O performance, this is usually used to quote random I/O performance. See throughput.
load	The process in which the drive takes in an inserted cartridge and goes online.
magazine	A holder for up to six tape cartridges used in autoloaders.

randomizing	A recoding of data symbols before they are written to tape in order to provide a consistently high RF envelope level. An inconsistent RF envelope is one of the criteria for rewriting a frame on read-after-write.
read-after-write (RAW)	Read-after-write improves data integrity by reading data immediately after it is written and writing the frame again if an error is found. The Audio DAT two-head drum is replaced by a four-head drum for this, with two read-only heads and two write-only heads. Frames are only re-written as necessary, so speed and capacity are affected minimally. RAW is included in the DDS format.
SCSI	Small Computer System Interface—a standard command specification and command set that enables computers and peripherals to n communicate with each other. Sun's current family of tape drives adhere to the SCSI-2 specification.
SCSI Address	The octal representation of the unique address (0–7) assigned to a narrow device; or hex representation of the unique address (0–15) assigned to a wide SCSI device.
sequential access	Sequential Access devices store data sequentially in the order in which it is received. Tape devices are the most common sequential access devices. Devices such as disk drives are Direct Access devices, where data is stored in blocks, not necessarily sequentially.
single-ended	SCSI devices can be single-ended or differential. *Single-ended* devices transmit signals by setting a line in the cable to a pattern of high and low voltages in relation to a ground line. *Differential* devices send signals by swapping over high and low states between two lines. This is more expensive to implement, but reduces interference and allows longer cable lengths. Sun's 4mm tape drives only support single-ended SCSI. *Note*: Single-ended and differential devices must not be mixed on one SCSI bus
stabilizing	Leaving a cartridge for a period of time in the room in which it is to be used in order to avoid condensation problems caused by changes in humidity and temperature. A period of two hours is recommended.
stacker mode	*Autoloaders only:* In Stacker mode, cartridges are used sequentially from the autoloader magazine. The cartridge selected by the user (by pressing the front panel Select button, and then loaded by pressing the Load button) is used first. When it is full, the changer mechanism automatically moves it back to the magazine, and then moves the cartridge in the next highest numbered slot to the drive. This continues until all the cartridges have been used. To load cartridges under host control, the device must be in Random mode. Stacker mode is sometimes referred to as Sequential mode.
SWIS/S	Single-ended Wide Intelligent SCSI/SBus host adapter.

Glossary *(cont.)*

synchronous	*See* data transfer
system area	A section in the Lead-in Area at the beginning of a partition used to store the tape usage information.
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, of C3 ECC retries, 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 into the System area on the tape when it is unloaded.
Tape Alert	The Tape Alert log holds a set of flags that indicate faults with the drive or tape. For example, the Not Data Grade flag is set to indicate that the drive has detected that a tape that is not Media Recognition System is loaded. By reading this log, host software or the operating system can inform users of existing or impending conditions and can give advice. For example, the software might recommend that you use a new tape or clean the heads.
termination	A SCSI bus (or cable) can have many devices plugged into it, but the end of the cable furthest from the host computer must always be *terminated* to avoid signals being reflected back and interfering with other signals. The terminator both absorbs signals and provides power to the lines in the cable. For this reason, it must itself be provided with power. Terminators can be of two types, active and passive. Active termination is recommended for a bus that has the tape drive on it, because although more expensive, it ensures better and more secure performance.
Throughput	A measure of sequential I/O performance, quoted in MB/sec. *See* IOPS.
time-tracking	A technique of ensuring that the read head stays in the center of the track that it is reading. The drive measures the time it takes to reach a particular