



.....

Scorpion 24 DDS-3 Tape Drive

.....

STD124000N

.....

STD224000N

.....

STD624000N

.....

Product Manual

.....

.....

Scorpion 24 DDS-3 Tape Drive

.....

STD124000N

.....

STD224000N

.....

STD624000N

.....

Product Manual

.....



© 1997 Seagate Technology, Inc. All rights reserved

Publication Number: 10004436-002, Rev. B, May, 1998

Seagate, Seagate Technology, the Seagate logo, Scorpion and the Scorpion logo are trademarks or registered trademarks of Seagate Technology, Inc. Other product names are trademarks or registered trademarks of their owners.

Seagate reserves the right to change, without notice, product offerings or specifications. No part of this publication may be reproduced in any form without written permission from Seagate Technology, Inc.

FCC Notice

This equipment generates and uses radio frequency energy and, if not installed and used properly—that is, in strict accordance with the manufacturer’s instructions—may cause interference to radio communications or radio and television reception. It has been tested and found to comply with the limits for a Class B computing device in accordance with the specifications in Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment on and off, you are encouraged to try to correct the interference by one or more of the following measures:

- Reorient the receiving antenna.
- Relocate the computer with respect to the receiver.
- Move the computer into a different outlet so that the computer and receiver are on different branch circuits.

If necessary, you should consult the dealer or an experienced radio/television technician for additional suggestions. You may find the following booklet prepared by the Federal Communications Commission helpful:

How to Identify and Resolve Radio-TV Interference Problems

This booklet (Stock No. 004-000-00345-4) is available from the U.S. Government Printing Office, Washington, DC 20402.

Warning. Changes or modifications made to this equipment which have not been expressly approved by Seagate Technology may cause radio and television interference problems that could void the user’s authority to operate the equipment.

Further, this equipment complies with the limits for a Class B digital apparatus in accordance with Canadian Radio Interference Regulations.

Cet appareil numérique de la classe B est conforme au Règlement sur brouillage radioélectrique, C. R. C., ch. 1374.

The external device drive described in this manual requires shielded interface cables to comply with FCC emission limits.

Additional Warnings:

- To prevent fire or electrical shock hazard, do not expose the unit to rain or moisture.
- To avoid electrical shock, do not open the cabinet.
- Refer servicing to qualified personnel.

About This Manual

All information contained in or disclosed by this document is considered proprietary by Seagate Technology. By accepting this material, the recipient agrees that this material and the information contained therein are held in confidence and in trust and will not be used, reproduced in whole or in part, nor its contents revealed to others, except to meet the purpose for which it was delivered. It is understood that no right is conveyed to reproduce or translate any item herein disclosed without express written permission from Seagate Technology.

Seagate Technology provides this manual “as is,” without warranty of any kind, either expressed or implied, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. Seagate Technology reserves the right to change, without notification, the specifications contained in this manual.

Seagate Technology assumes no responsibility for the accuracy, completeness, sufficiency, or usefulness of this manual, nor for any problem that may arise from the use of the information in this manual.

Following are brief descriptions of the sections in this manual.

Chapter 1, “Introduction” on page 1 provides general specifications, features and an overview on DAT technology.

Chapter 2, “Specifications” on page 9 contains physical, performance, environmental, power, drive tape handling and DAT cartridge specification tables.

Chapter 3, “Installation” on page 15 provides cautions, unpacking tips, inspection information and installation/connection steps, including cabling requirements and connector pinouts.

Chapter 4, “Drive Operations” on page 33 explains the simple operation of drives.

Chapter 5, “SCSI Interface” on page 43 lists general information about the SCSI-2 interface.

Chapter 6, “DDS-3 Tape Format” on page 47 explains the DDS, DDS-DC, DDS-2 and DDS-3 tape formats.

Chapter 7, “Data Compression” on page 61 describes the data compression algorithm and explains pertinent information for effective use of data compression.

Chapter 8, “Theory of Operations” on page 71 details the functional operation of various assemblies of the drives.

Chapter 9, “Maintenance and Reliability” on page 83 presents maintenance procedures and reliability information.

Appendix A, “Acronyms and Measurements” on page 87 lists the acronyms and measurements used in the manual.

Appendix B, “Vendor-Unique SCSI Information” on page 91 provides specific SCSI information for programming and retrieving configuration data.

The glossary on page 95 defines key terms.

Contents

1	<i>Introduction</i>	1
	Overview.....	1
	DDS Format Standard Compatibility.....	1
	Scorpion 24 Capacity and Transfer Rates.....	2
	Features.....	3
	Models.....	4
	DAT Technology Overview.....	6
	Helical Scan Recording.....	6
	Recording Formats.....	7
	DDS-3 Recording Format.....	7
	DDS-2 Recording Format.....	7
	DDS Recording Format.....	7
	DDS-DC Recording Format.....	8
2	<i>Specifications</i>	9
	Overview.....	9
	Physical Specifications.....	9
	Power Specifications.....	11
	Drive Performance Specifications.....	12
	Environmental Requirements.....	13
	DDS Cartridge Specifications.....	13
	Regulatory Compliance.....	14
3	<i>Installation</i>	15
	Introduction.....	15
	Guidelines and Cautions (Internal Models).....	15
	Unpacking and Inspection.....	16
	Cabling and Connectors.....	16
	Cabling Considerations.....	16
	Electrical Characteristics.....	16
	SCSI Connector—Internal Models.....	18
	SCSI Connector—External Models.....	19
	Installing Internal Drives.....	20
	Configuring Options.....	20
	Setting the Switchbank Parameters.....	20
	SCSI Device Address (S1, S2, S3).....	22
	Media Recognition System (MRS) (S4).....	22

	Parity Check Enable/Disable (S5)	23
	DDS Pass-Through Mode Enable/Disable (S6)	23
	Inquiry String (S7).....	23
	Power-on Self-Test Mode Enable/Disable (S8)	23
	Switches 9 and 10	23
	Setting the Jumpers.....	24
	SCSI Device Address Jumpers.....	25
	Hardware Data Compression	26
	Active Terminator	26
	Terminator Power	26
	Mounting the Drive.....	27
	Completing the Power and Interface Connections	29
	Installing External Drives.....	29
	Selecting the SCSI Address.....	30
	Completing the Interface Connection	30
	Connecting the Power Cord	31
4	<i>Drive Operations</i>	33
	Introduction	33
	Data Compression Operation	33
	Front Panel LED Operation	34
	Loading/Unloading the Cartridge	37
	Loading/Unloading a Cartridge (Normal Operation)	37
	Unloading a Cartridge (Manual Operation)	38
	Using a Blank Cartridge	39
	Using a Cartridge Containing Data	40
	Loading Revised Firmware Using Seagate Firmware Cartridges.....	40
	Flash Memory	40
	Firmware Download Process.....	41
5	<i>SCSI Interface</i>	43
	Introduction	43
	SCSI-2 Interface	43
	ANSI X3.131, 199x Conformance Statement (SCSI-2)	45
	General Features	45
	Typical System Configurations	46
6	<i>DDS-3 Tape Format</i>	47
	Introduction to DDS Recording Format Standards	47
	DDS-3 Tape Format.....	47
	Basic Groups.....	48
	Entities	49
	Subgroups	49
	Basic Group Transformation Summary	49
	Subcode Information.....	49

	Subcode Location	49
	DDS-3 Track Geometry	50
	Recorded Patterns	51
	Format of a Track	51
	Positioning Accuracy.....	52
	Timing Tracking	52
	Tape Layouts in the DDS-3 Standard	53
	Layout of a Single Data Space Tape (Single Partition).....	53
	Device Area	54
	Reference Area.....	54
	System Area	55
	Data Area	55
	Appending to Tape.....	55
	EOD Area	57
	Early Warning Point (EWP).....	57
	Initialization.....	57
	Layout of a Partitioned Tape	58
	Partition 1	59
	Partition 0	59
	Initialization of Partitioned Tapes.....	59
	Housekeeping Frames	60
	DDS-3 Recording Format Standard—Further Reference	60
7	Data Compression	61
	Introduction	61
	Data Compression—General.....	61
	Data Compression Considerations	62
	Hardware Compression	63
	Data Integrity	63
	DCLZ Algorithm	64
	DCLZ Algorithm	64
	Simplified Compression Operation	64
	Dictionary	65
	Simplified Decompression Operation.....	66
	SCSI/Data-Compression Chip	68
	Overview	68
	Features	68
8	Theory of Operations.....	71
	Overview.....	71
	The STD124000N Drive.....	72
	Motors and Control Circuits.....	73
	SCSI Controller.....	74
	Helical Scan Recording—Four-Head Design	75
	Motors and Control Circuits.....	76
	Read and Write LSI	77
	Timing Tracking Circuitry	77
	SCSI Controller.....	77

Flash Memory	77
Sensors	78
Read-After-Write	78
Media Recognition System (MRS).....	79
DDS Data Cartridge	79
9 Maintenance and Reliability	83
Maintenance	83
Head Cleaning	83
Automatic Drive Spin-Down and Write	84
Guidelines for High Temperature or Humidity Conditions (Outside the Specified Operating Environment).....	84
Reliability	85
Mean Time Between Failures.....	85
Mean Time To Repair	85
A Acronyms and Measurements	87
Acronyms and Abbreviations.....	87
Measurements	89
B Vendor-Unique SCSI Information	91
Overview.....	91
MODE SELECT Flash Memory Configuration Page (30 _H).....	92
MODE SENSE Flash Memory Configuration Page (30 _H).....	93
Glossary.....	95

Figures

Figure 1. 3.5-inch Internal DDS Drive	5
Figure 2. 5.25-Inch Internal DDS Drive	5
Figure 3. External DDS Drive	6
Figure 4. Internal DDS Drive—General Dimensions	10
Figure 5. Internal DDS Drive with Rails—General Dimensions.....	10
Figure 6. External Subsystem—General Dimensions	11
Figure 7. Switchbank Access—3.5-Inch Internal Model	20
Figure 8. Switchbank Access—5.25-Inch Internal Model	21
Figure 9. Dip Switch Default Settings	22
Figure 10. Location of Jumpers for Internal Model	24
Figure 11. Location of Jumpers for Internal Model with Rails	24
Figure 12. Jumper Configurations.....	25
Figure 13. Mounting Hole Locations (Internal Drive without Rails).....	27
Figure 14. Mounting Hole Locations (Internal Drive with Rails)	28
Figure 15. Rear Panel (External Model).....	30
Figure 16. Daisy Chain Diagram.....	31
Figure 17. Front Panel—Internal Model	35
Figure 18. Front Panel—Internal Model with Rails	36
Figure 19. Front Panel—External Subsystem.....	36
Figure 20. Cartridge Loading (Internal DAT Drive)	37
Figure 21. Locations on Drive.....	38
Figure 22. SCSI System Sample Configurations.....	46
Figure 23. Structure of a Basic Group	48
Figure 24. Track Configuration	50
Figure 25. Timing Tracking.....	53
Figure 26. Layout of a Single Data Space Tape.....	54
Figure 27. Appending Rules	55
Figure 28. Tolerance on Seamless Appending	56
Figure 29. Layout of a Partitioned Tape.....	58
Figure 30. Layout of SCSI/Data Compression Device.....	69
Figure 31. Simplified Block Diagram—Scorpion 24 DDS-3 Drive	73
Figure 32. Block Diagram—SCSI Controller DAT Models	74
Figure 33. Four-Head Design	75
Figure 34. Alternate Azimuth Angles	76
Figure 35. DDS Cartridge	80
Figure 36. Cartridge Design Features.....	81
Figure 37. Write-Protect Tab on the DDS Cartridge.....	81

Overview

The Seagate® Scorpion® 24 digital data storage (DDS) drive is designed for computer environments that require high-performance, high-capacity data storage. Based on a 3.5-inch mechanism, the internal and external Scorpion 24 models provide 12 Gbytes of data-storage capacity, 24 Gbytes compressed, with a native transfer rate of 1.1 Mbytes per second, 2.2 Mbytes per second compressed.

The Scorpion 24 drive combines established DAT technology, high-density recording and hardware data-compression capability along with Seagate's proven computer grade design to provide unmatched reliability and performance characteristics among DDS products. The Scorpion 24 is ideal for workstation, server and network/enterprise applications such as:

- Backup of high-capacity fixed discs
- Data interchange between systems
- Network server
- Loader products
- Online data collection
- Near-line secondary storage for text, graphics or multimedia information of all types
- Archival storage

DDS Format Standard Compatibility

The Scorpion 24 drive supports the DDS-3, DDS-2 and DDS recording formats. Compatibility with each of these standards ensures complete write and read interchange of recorded digital data between all compliant drive and media vendors.

Additionally, the Scorpion 24 drive supports DDS-DC, the DDS data compression standard, effectively doubling storage capacity and transfer rates.

The Scorpion 24 drive complies with:

- The DDS recording format standard, *ANSI/ECMA-139, 3,81mm Wide Magnetic Tape Cartridge for Information Interchange - Helical Scan Recording - DDS Format.*
- The DDS-DC recording format standard, *ANSI/ECMA-150, 3,81mm Wide Magnetic Tape Cartridge for Information Interchange - Helical Scan Recording - DDS-DC Format using 60 m and 90 m Length Tapes.*
- The DDS-2 recording format standard, *ANSI/ECMA-198, 3,81mm Wide Magnetic Tape Cartridge for Information Interchange - Helical Scan Recording - DDS-2 Format using 120 m Length Tapes.*
- The DDS-3 recording format standard, *ANSI/ECMA-236, 3,81mm Wide Magnetic Tape Cartridge for Information Interchange - Helical Scan Recording - DDS-3 Format using 125 m Length Tapes.*

Scorpion 24 Capacity and Transfer Rates

The Scorpion 24 provides the following capacities and transfer rates, depending on recording mode and tape length:

	Recording Mode			
	DDS	DDS-DC	DDS-2	DDS-3
Tape length	60 meter	90 meter	120 meter	125 meter
Capacity (native)	1.3 Gbytes	2.0 Gbytes	4.0 Gbytes	12.0 Gbytes
Capacity (compressed)	N/A	4.0 Gbytes	8.0 Gbytes	24.0 Gbytes
Transfer rate (native)	780	780	780	1.1
	Kbytes/sec	Kbytes/sec	Kbytes/sec	Mbytes/sec

In data-compression mode, the Seagate Scorpion 24 drive typically doubles the storage capacity and transfer rate of the native uncompressed operation. Tape capacity and sustained data-transfer rate are also dependent upon the characteristics of the files being compressed, along with other system parameters, including the speed of the host, the operating system and the application software used.

The Scorpion 24 drive also offers synchronous or asynchronous SCSI transfers with a high-speed burst data-transfer rate of 10 Mbytes per second.

The Scorpion 24 provides unmatched reliability through three levels of error-correction code (ECC) and the four-head design, which provides for read-after-write (RAW) error detection and correction. The Scorpion 24 also contains an onboard serial port that provides the capability for extensive testing of the drives.

Features

The Scorpion 24 DDS drive represents Seagate's commitment to engineering reliable and durable tape drive products that implement leading-edge technology. Key features of the drive include:

- Platform based on 3.5-inch DDS drive components
- 3.5-inch internal form-factor for installation in a 3.5-inch half-height space (model STD124000N)
- 3.5-inch drive with factory-installed 5.25-inch mounting rails and bezel for installation in a 5.25-inch half-height space (model STD224000N)
- External subsystem with built-in, auto-sensing, worldwide power supply (model STD624000N)
- Capability to write and read DDS-3, DDS-2, DDS-DC and DDS cartridges
- Advanced onboard DDS-DC hardware using Data Compression Lempel-Ziv (DCLZ) data-compression algorithm
- ANSI/ECMA DDS-3, DDS-2, DDS-DC and DDS tape format compliance for compatibility and interchange
- High-speed random access of 20 seconds (average) to any file on a 60 m tape; 30 seconds for a 90 m tape; 40 seconds on a 120 m tape; and 40 seconds on a 125 m tape
- High-speed transfer rates for fast backups:
 - 1.1 Mbytes per second (66 Mbytes per min) typical—uncompressed data
 - 2.2 Kbytes per second (132 Mbytes per min) typical—compressed data
- High-performance SCSI burst transfer rate of 7 Mbytes per second asynchronous and 10 Mbytes per second synchronous
- Flash memory to store setup parameters
- Four-head design with RAW error detection and rewrites
- Three levels of ECC to ensure data integrity
- Uncorrectable error rate of less than 1 in 10^{15} bits
- Flash memory to enable field firmware upgrades
- Custom Seagate-designed LSI circuitry to reduce component count and boost drive reliability
- Advanced, single-chip, DDS formatter LSI
- Low power consumption—less than 5.5 watts (typical) for internal drives

- Single-ended SCSI connection with these features:
 - Embedded full LSI, high-speed SCSI-2 controller
 - Software selectable synchronous or asynchronous SCSI data transfer
 - Onboard output jack on internal models for configuring the SCSI address if repackaged in an external box
- Automatic power-on self-tests available
- Manual emergency cartridge ejection procedure
- Support for TapeAlert™ Certified Solutions

Models

The Scorpion 24 3.5-inch and 5.25-inch internal drive form-factors are tailored for easy installation in today's computers, and the full-featured embedded SCSI controller facilitates easy integration into a variety of systems.

Scorpion 24 Model Names

Capacity	24.0 Gbytes*
3.5-in internal	STD124000N
5.25-in internal	STD224000N
External	STD624000N

*Typical with data compression

Scorpion 24 models include:

- A 3.5-inch, half-height DDS-3 drive that mounts internally (model STD124000N).
- A 5.25-inch, half-height DDS-3 drive that consists of a 3.5-inch drive with 5.25-inch mounting rails and bezel that mounts internally in a 5.25-inch, half-height space (model STD224000N).
- A complete external subsystem that contains the 3.5-inch DDS-3 drive and built-in worldwide power supply (model STD624000N).

Figures 1, 2 and 3 illustrate the internal, internal with rails and external drives, respectively.

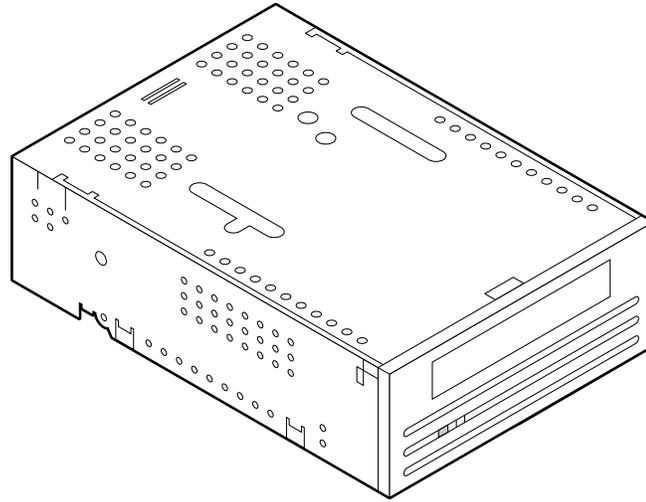


Figure 1. 3.5-Inch Internal DDS Drive

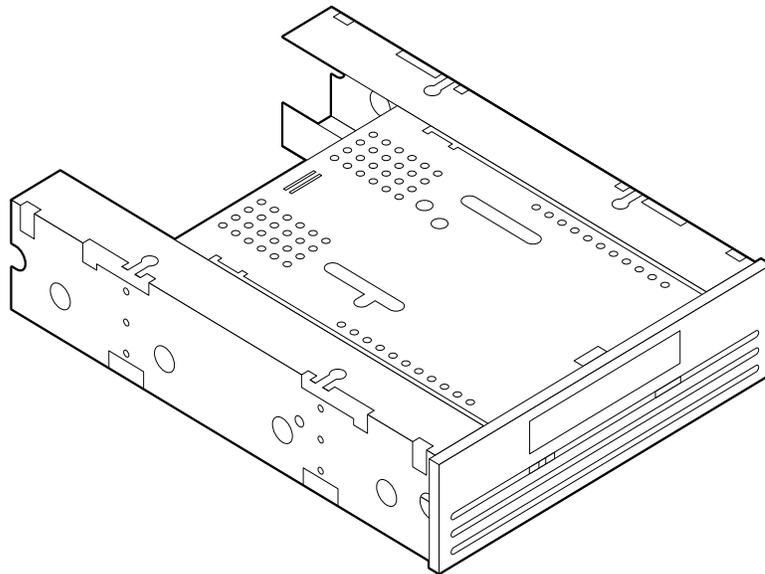


Figure 2. 5.25-Inch Internal DDS Drive

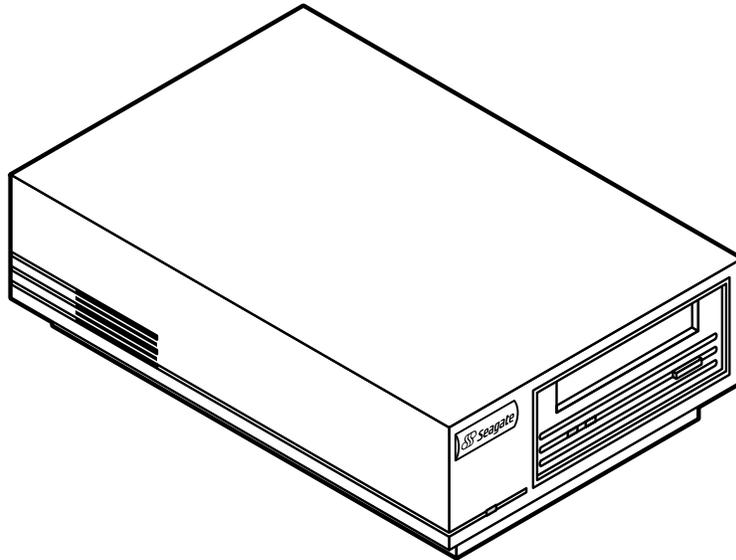


Figure 3. External DDS Drive

DAT Technology Overview

Developed for the audio electronics market, DAT technology was first applied in computer peripherals in the late 1980s. Unlike traditional magnetic tape audio cartridge products, DAT technology proves inherently reliable through the *helical scan recording method*, which provides a high recording density with a very low error rate. All DAT products, including computer implementations, use the helical scan recording method. This recording method has been used in professional video tape recorders (VTRs) since 1956 and in home video cartridge recorders (VCRs) since 1974. In 1986, DAT products that used helical scan technology were first developed for audio applications. DAT consumer products are specifically designed for digital audio recording and playback.

Helical Scan Recording

Helical scan recording was originally developed as a method of efficiently recording high-quality television signals on a relatively slow moving tape. It requires that both the tape and the recording head move simultaneously. This recording method results in an extremely high recording density, far higher than can be achieved with stationary-head devices such as 1/2-inch open-reel or 1/4-inch cartridge tapes. (See chapter 8, "Helical Scan Recording—Four-Head Design" for additional information.)

In helical scan recording, both the read and write heads are located on a rapidly rotating cylinder or drum. The cylinder is tilted at an angle in relation to the vertical axis of the tape. As the tape moves horizontally, it wraps around the part of the circumference of the cylinder (102°) so that the head enters at one edge of the tape and exits at the other edge before the tape unwraps.

The horizontal movement of the tape in combination with the angular movement of the cylinder causes the track to be recorded diagonally across the tape rather than straight down its length. The resulting recorded track, nearly one inch, is approximately eight times longer than the width of the tape.

Recording Formats

The Seagate Scorpion 24 DDS drive is designed to comply with the industry-standard DDS-3, DDS-2, DDS-DC and DDS recording formats. These formats are summarized in the following text.

DDS-3 Recording Format

The DDS-3 recording format provides for writing data in helical tracks that are the same width as DDS-2. The significant capacity increase associated with DDS-3 is achieved by: 1) doubling linear recording density from 61 Kbpi (DDS-2) to 122 Kbpi along with the use of PRML encoding; 2) increasing tape length to 125 meters and 3) using the timing tracking system, which eliminates the need for dedicated top and bottom servo burst information associated with the previous ATF system.

DDS-2 Recording Format

The DDS-2 or narrow track recording format provides for writing data in helical tracks that are narrower than the previous DDS track width. This format doubles capacity by increasing track density one and a half times, along with a 33% increase in tape length; the higher output MP+ media associated with the 120-m DDS-2 cartridges ensures reliable data integrity given the decrease in track widths from 13.6 μm with DDS and DDS-DC to 9 μm with DDS-2.

DDS Recording Format

This standard format was codeveloped by DDS manufacturers to support DAT devices as computer peripherals. The objectives of DDS are to maximize storage capacity and performance, facilitate data interchange, provide compatibility with existing tape storage command sets and provide extremely fast random access. The DDS format also takes advantage of the helical scan recording method and the inherent error correction capability of the DAT technology to augment error detection and correction.

The format consists of a finite sequence of data groups where each data group is a fixed-length recording area. A data group is made up of 22 data frames and 1 ECC frame; each frame is made up of two helical scan tracks. The advantages of the fixed-length data group is that ECC is easily generated, and buffering requirements are simplified. (See Chapter 6, "Tape Formats," for additional information.)

Although data groups are fixed-length and always contain 22 data frames, the DDS format is designed such that variable-length computer records can be stored in the fixed-length data groups.

DDS-DC Recording Format

A superset of the basic DDS format, DDS-DC drives can write compressed and uncompressed data to the same cartridge. Because DDS-DC is based on the DDS format, backward-compatibility is maintained.

Introduced by the DDS Manufacturers Group and approved by ANSI and ECMA, DDS-DC is a *record compression* industry-standard format that provides support for *lossless* compression algorithms based on substitution—such as those of the Lempel-Ziv family.

This format supports compressed and uncompressed records. A recorded DDS cartridge may contain compressed records, uncompressed records, filemarks and setmarks. Compressed records exist within recorded objects called *entities*. Entities and uncompressed records are collected into groups.

Many aspects of the DDS-DC format are identical to those of the DDS format:

- The series of transformations (randomizing, interleaving, generation and inclusion of two Reed-Solomon error-correction codes) applied to a group before recording
- The tape layout
- The third group-based level of Reed-Solomon error-correction codes (C3)

The only differences between the DDS and DDS-DC formats are in the contents of the groups.

Overview

This chapter includes technical specifications for the internal and external SCSI drives. This information covers the following specifications and requirements:

- Physical specifications
- Power requirements
- Drive performance specifications
- Environmental requirements
- DAT cartridge specifications
- Regulatory compliance

Physical Specifications

The physical specifications of the Scorpion 24 internal and external models are listed in the following table:

Specification	Internal	Internal with rails	External
Height	1.6 in/41.2 mm	1.6 in/41.2 mm	2.7 in/69 mm
Width	4.0 in/101.6 mm	5.7 in/146.0 mm	6.1 in/155.0 mm
Length	5.7 in/146.0 mm	6.9 in/175.0 mm	9.3 in/236.0 mm
Weight	2.0 lb/0.85 kg	2.4 lb/1.1 kg	4.1 lb/1.8 kg

Figures 4, 5 and 6 illustrate the general dimensions of the internal and external drive models. Drive dimensions are in millimeters.

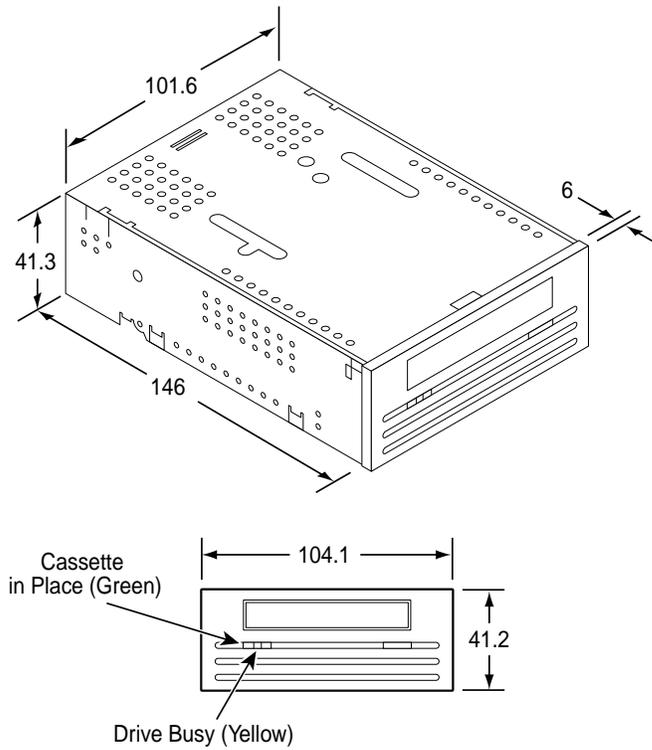


Figure 4. Internal DDS Drive—General Dimensions

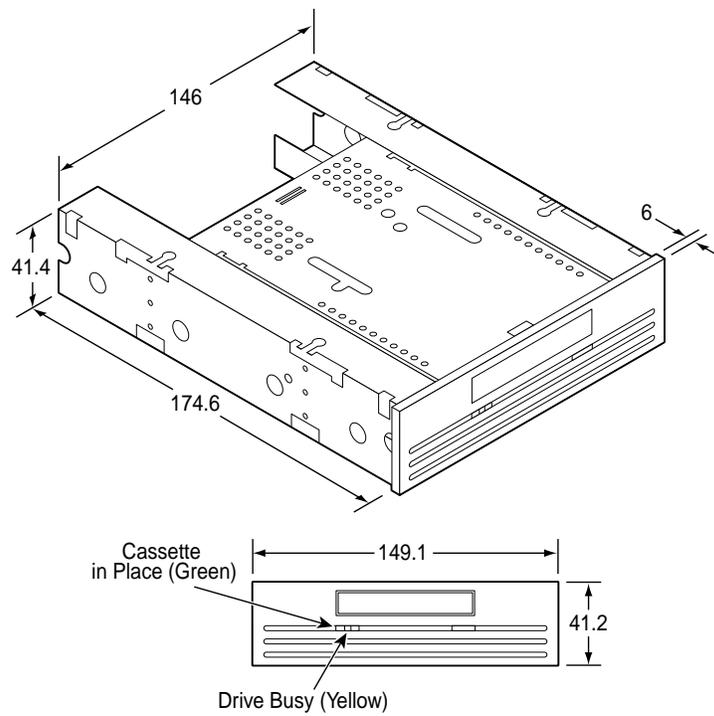


Figure 5. Internal DDS Drive with Rails—General Dimensions

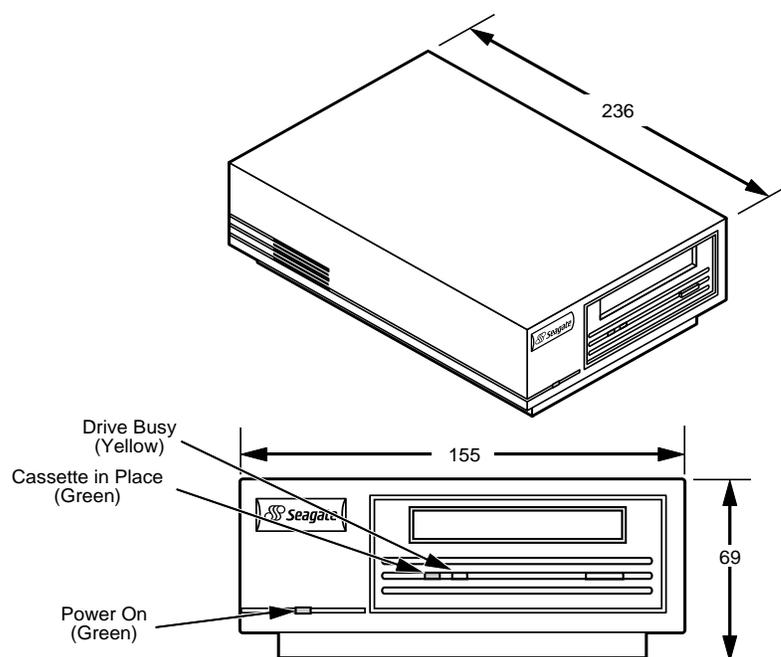


Figure 6. External Subsystem—General Dimensions

Power Specifications

The following table lists the power specifications for the internal Scorpion 24 drives.

DC Voltage	+12 VDC	+5 VDC
Voltage Tolerance	+ or – 10%	+ or – 7%
Operational Current	250 milliamps	600 milliamps
Standby Current	50 milliamps	550 milliamps
Peak	600 milliamps	800 milliamps
Ripple (peak-to-peak)	≤ 100 mV	≤ 100 mV
Power dissipation (Standby)	< 3.3 watts	< 2.2 watts
Power dissipation (Operating)	< 5.5 watts	< 5.5 watts

The following table lists pin assignments of the power connector for the internal models.

Pin	Assignment
1	+12 VDC
2	+12 return
3	+5 return
4	+5 VDC

The external drives have a built-in power supply that senses the incoming voltage and automatically adapts to voltages within the range of 100 to 240 volts, 50 to 60 Hz. The following table lists its power specifications.

Specification	AC Input Voltage		
	<i>100 (Japan)</i>	<i>120 (US)</i>	<i>240 (European)</i>
AC Input Current	100 milliamps	85 milliamps	170 milliamps
AC Input Power	10.0 watts	10.0 watts	10.0 watts

Drive Performance Specifications

The following table lists the specifications for the Scorpion 24 drive.

Capacity	
60 m MP	2.6 Gbytes
90 m MP	4.0 Gbytes
120 m MP+	8.0 Gbytes
125 m MP++	24.0 Gbytes
Recording density	122,000 bpi
Flux density	152,400 fpi
Track density	2,804 tpi
Error recovery	Read-after-write Reed Solomon ECC (C3 - 3 levels)
Recording unrecoverable errors	< 1 in 10 ¹⁵ data bits
Tape drive type	Computer grade 4DD mechanism
Head configuration	2 read heads, 2 write heads
Recording format	DDS-3
Recording method	Helical scan (R-DAT)
Cartridge	2.9 in x 2.1 in x 0.4 in
Transfer rate (sustained)	2,200 Kbytes per sec DC ON
Synchronous transfer rate (burst)	10 Mbytes per sec max
Asynchronous transfer rate (burst)	7 Mbytes per sec max
Search speed	200 X normal speed
Average access time	
60 m cartridge	<20 sec
90 m cartridge	<30 sec
120 m cartridge	<40 sec
125 m cartridge	<40 sec
Drum rotation speed	4,000 RPM (DDS-3 mode) 8,000 RPM (DDS-2, DDS modes)
Tape speed	0.43 in per sec
Head-to-tape speed	246.94 in per sec

Environmental Requirements

The following table lists the environmental specifications for DDS drives. You can mount internal DDS drives either vertically (drive left side up or right side up) or horizontally.

Specification	Operational	Nonoperational
Temperature	+41° to +113°F ¹ (+ 5° to + 45°C)	-40° to +149°F ² (-40° to + 65°C)
Thermal gradient	2°C per minute (no condensation)	Below condensation
Relative humidity	20% to 80% noncondensing ¹	0% to 90% noncondensing ²
Maximum wet bulb temperature	78.8°F (26°C)	No condensation
Altitude	-100 to +4,575 meters	-300 to +15,200 meters (power off)
Vibration	—	1.5 g (5 to 500 Hz)
Sweep Test	1.20 mm peak-to-peak (5–17 Hz)	—
Sweep Rate	0.73 G peak (17 to 150 Hz) 0.50 G peak (150–500 Hz) 8 decades per hour	—
Dwell Test (15 min)	0.90 mm peak-to-peak (5–17 Hz) 0.55 G peak (17–150 Hz) 0.25 G peak (150–500 Hz)	—
Acoustic level idling (A-wt sum)	45 dBA maximum	—
Acoustic level operational (A-wt sum)	50 dBA maximum (measured in suitable enclosure at 3-ft distance and operator height)	—
Shock (1/2 sine wave)	10 Gs peak, 11 msec	50 Gs peak, 11 msec

1. Mechanism and media

2. Mechanism

DDS Cartridge Specifications

DDS drives provide maximum data integrity and reliability when Seagate-qualified DDS cartridges are used as the recording media. Seagate maintains an ongoing program to qualify manufacturers of DDS cartridges.

The following cartridges are recommended:

- DDS data cartridge: model M31300, 60-meter tape
- DDS data cartridge: model M32000, 90-meter tape
- DDS-2 data cartridge: model M34000, 120-meter tape
- DDS-3 data cartridge: model M312000, 125-meter tape
- DDS cleaning cartridge: model M91301

Contact your Seagate sales representative for information on qualified DDS data and cleaning cartridge manufacturers and models.

Regulatory Compliance

These DDS drives comply with the regulations listed in the following table.

Agency	Regulation
CSA	C22.2, No. 950-M89
TUV-RHEINLAND	EN 60 950
UL	1950
FCC	Class A and Class B ¹
CE	CE compliance

1. Required compliance for external model; verification on file for internal models.

Use these drives only in equipment where the combination has been determined to be suitable by an appropriate certification organization (for example, Underwriters Laboratories Inc. or the Canadian Standards Association in North America). You should also consider the following safety points:

- Install the drive in an enclosure that limits the user's access to live parts, gives adequate system stability and provides the necessary grounding for the drive.
- Provide the correct voltages (+5 VDC and +12 VDC) based on the regulation applied—Extra Low Voltage (SELV) for UL and CSA and Safety Extra Low Voltage for BSI and VDE (if applicable).

Introduction

This chapter explains how to install the Scorpion 24 drive. Some of the information relates to all models; other information is specifically aimed at either the internal or external models. The following paragraphs briefly outline the organization of this chapter.

- **Guidelines and Cautions:** lists guidelines for handling the internal drive.
- **Unpacking and Inspection:** contains general information that you should read before installation.
- **Cabling and Connectors:** gives specific cabling requirements and connector pinouts for the drive.
- **Installing the Internal Drives:** describes installing the 3.5-inch internal drive and the 3.5-inch drive with 5.25-inch mounting rails and bezel.
- **Installing the External Drive:** describes installing the external subsystem.

Guidelines and Cautions (Internal Models)

The following guidelines and cautions apply to handling and installing the Scorpion 24 internal drive. Keep them in mind as you install the drive.

- Internal drives contain some exposed components that are sensitive to static electricity. To reduce the possibility of damage from static discharge, the drives are shipped in a protective antistatic bag.
- Do not remove the drive from the antistatic bag until you are ready to install it.
- Before you remove the drive from the antistatic bag, touch a metal or grounded surface to discharge any static electricity buildup from your body.
- Hold the drive by its edges only, and avoid direct contact with any exposed parts of the printed circuit board (PCB).
- While not installed, always lay the drive either on top of the antistatic bag or place it inside of the bag to reduce the chance of damage from static discharge.

Unpacking and Inspection

Although drives are inspected and carefully packaged at the factory, damage may occur during shipping. Follow these steps for unpacking the drive.

1. Visually inspect the shipping containers and notify your carrier immediately of any damage.
2. Place shipping containers on a flat, clean, stable surface; then carefully remove and verify the contents against the packing list.

If parts are missing or the equipment is damaged, notify your Seagate representative.

3. Always save the containers and packing materials for any future reshipment.

Cabling and Connectors

The Scorpion 24 drive provides a standard single-ended SCSI interface. ANSI SCSI standards specify the technical requirements for correctly cabling and connecting single-ended devices. This section provides some basic information about SCSI cabling and connectors for the drives.

Cabling Considerations

You can use either a 50-pin flat cable or a 25-signal twisted-pair cable with a maximum length of 6 meters (19 feet) to connect the drives to the SCSI host adapter output. If twisted-pair cabling is used, connect the twisted pairs to physically opposing contacts on the connector.

A stub length no greater than 0.1 meter should be used off the mainline connection within any connected equipment.

The cable characteristic impedance should be between 90 ohms and 140 ohms. A cable characteristic impedance of greater than 100 ohms is recommended.

To minimize noise and ensure even distribution of terminator power, the minimum recommended conductor size is 28 AWG (0.08042 mm²).

Electrical Characteristics

This section lists measurements of various electrical signals in relation to the single-ended SCSI connection. For these measurements, SCSI bus termination is assumed to be external to the SCSI device.

All signals except GROUND and TEMPWR must be terminated at both ends of the cable. Each signal termination consists of 220 ohms ($\pm 5\%$) to TEMPWR and 330 ohms ($\pm 5\%$) to GROUND and must meet the following specifications or requirements:

- Terminators must supply a characteristic impedance of 100 to 132 ohms.
- External terminators must be powered by the TEMPWR line, and units that provide terminator power to the cable must have:

$$V_{\text{TERM}} = 4.25 \text{ to } 5.25 \text{ VDC}$$

900 milliamps minimum source drive capability

The external drive normally supplies terminator power to the SCSI bus.

- When TEMPWR matches the above values, the voltage of released signal lines must be at least 2.5 VDC.
- When a driver asserts a line and pulls it to 0.5 VDC, the current available to the signal line driver may not exceed 48 milliamps. The first two terminators may only supply 44.8 milliamps of this current.
- When at least one device supplies TEMPWR, these conditions may be met by any valid configuration of targets and initiators.

All signals use open-collector drivers. The output characteristics (measured at the connector of the drive) of signals driven by the drive are:

- Signal assertion (low-level output voltage): 0.0 to 0.5 VDC at 48 milliamps sinking
- Signal negation (high-level output voltage): 2.5 to 5.25 VDC

Signals received by the drive have the following characteristics.

- Signal assertion (low-level input voltage): 0.0 to 0.8 VDC
- Signal negation (high-level input voltage): 2.0 to 5.25 VDC
- Maximum input load (low-level input current): -0.4 at 0.5 VDC
- Minimum input hysteresis: 0.2 VDC

SCSI Connector—Internal Models

The internal drive provides a 50-pin, right-angle, dual-row connector on the main PCB at the rear of the drive. The pin assignments for this single-ended connector are listed in the following table.

Note. All odd pins, except pin 25, are connected to signal ground at the drive. Pin 25 is left open. A signal name or abbreviation preceded by a dash indicates that the signal is active-low.

Pin	Assignment
2	–DB(0)
4	–DB(1)
6	–DB(2)
8	–DB(3)
10	–DB(4)
12	–DB(5)
14	–DB(6)
16	–DB(7)
18	–DB(P)
20	GROUND
22	GROUND
24	GROUND
26	TERMINATOR POWER ¹
28	GROUND
30	GROUND
32	–ATN
34	GROUND
36	–BSY
38	–ACK
40	–RST ²
42	–MSG
44	–SEL
46	–C/D
48	–REQ
50	–I/O

1. The +5V drive supply is available on the SCSI connector as a terminator power option. This pin is connected to the +5V through a diode. The option is selected by a jumper at the rear of internal drives. Terminator power disabled is the factory default.

2. ANSI defines –RST as a bidirectional pin. On the drive, –RST is input only.

SCSI Connector—External Models

The external drive provides two 50-pin, shielded connectors (ANSI Alternative 2) on the rear panel of the drive. These connectors consist of two rows of ribbon contacts spaced 2.16 mm (0.085 in) apart.

These two connectors facilitate adding the drive to a daisy-chain configuration. Either connector is a SCSI IN connection; the other is a SCSI OUT connection. When the drive is the last device in the chain (or the only device), an external terminator is plugged in the SCSI OUT connector.

The pin assignments for these single-ended connectors are listed in the following table.

Note. Pins 1 through 12 and 14 through 25 are connected to ground. Pin 13 is open. A signal name or abbreviation preceded by a dash indicates that the signal is active-low.

Pin	Assignment
26	-DB(0)
27	-DB(1)
28	-DB(2)
29	-DB(3)
30	-DB(4)
31	-DB(5)
32	-DB(6)
33	-DB(7)
34	-DB(P)
35	GROUND
36	GROUND
37	GROUND
38	TERMINATOR POWER
39	GROUND
40	GROUND
41	-ATN
42	GROUND
43	-BSY
44	-ACK
45	-RST
46	-MSG
47	-SEL
48	-C/D
49	-REQ
50	-I/O

Installing Internal Drives

The two internal models are a 3.5-inch drive that mounts internal to the computer in a 3.5-inch, half-height space and a 3.5-inch drive with mounting rails and bezel for internal installation in a 5.25-inch, half-height space.

Installing these two models consists of a few easy steps:

1. Configure the switchbank parameters and set the jumpers.
2. Mount the drive unit.
3. Complete the power and interface connections.

The installation procedure is the same for both models except physically mounting the unit in the computer. The following text explains the installation steps for both models.

Configuring Options

You can configure various operational options on the Scorpion 24 by setting the switches on a switchbank at the base of the drive or by setting jumpers on a jumper block at the rear of the drive. The directions for setting both switches and jumpers are given in the following subsections.

Setting the Switchbank Parameters

Set the switches before you install the drive in the computer. Figure 7 illustrates the switchbank location for the 3.5-inch internal drive (bottom of the drive is shown).

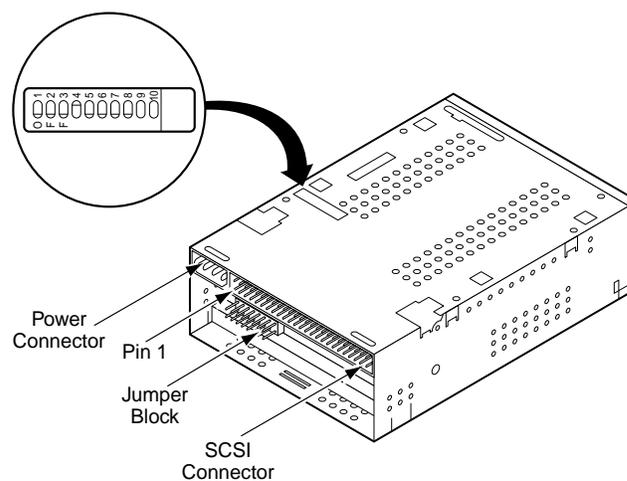


Figure 7. Switchbank Access—3.5-Inch Internal Model

Figure 8 illustrates the switchbank location for the 5.25-inch internal drive (bottom of the drive is shown).

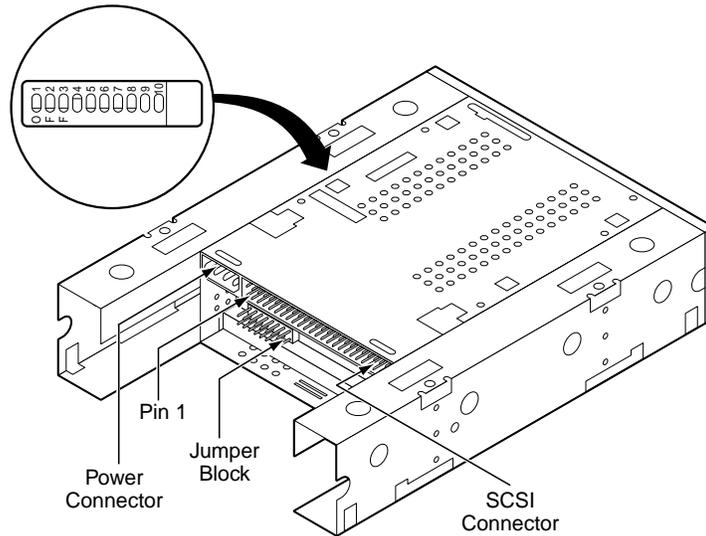


Figure 8. Switchbank Access—5.25-Inch Internal Model

The Scorpion 24 switchbank allows you to configure the SCSI device address, media-recognition system (MRS) mode, parity check, DDS pass-through mode (data-compression mode), Seagate's selectable inquiry string and power-on self-test (POST).

Following are brief descriptions of the various positions and with their default values.

- SCSI device address (S1, S2, S3):
Default: SCSI ID = 0 (S1= OFF, S2 = OFF, S3 = OFF)
- Media-recognition system (MRS) mode (S4):
Default: MRS check disabled (S4 = ON)
- Parity check enable/disable (S5):
Default: Parity disabled (S5 = OFF)
- DDS pass-through mode enable/disable (S6):
Default: Pass-through mode disabled (S6 = OFF)
When S6 is OFF, data compression is enabled.
When S6 is ON, data compression is disabled.
- Inquiry string selection (S7):
Default: Seagate inquiry string (S7 = ON)
- Power-on self-test enable/disable (S8):
Default: Power-on self-test disabled (S8 = OFF)
- Reserved (S9 and S10):
Do not use these switches.

Figure 9 shows the default switch settings.

OFF	S10	S9	S8	S7	S6	S5	S4	S3	S2	S1	
ON	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
	Reserved (do not use)	Self-test	Inquiry String	DDS Pass- through	Parity	MRS Mode	SCSI ID Selection			SCSI ID	
OFF		Disable	Archive	DDS-DC	Disable	MRS	OFF	OFF	OFF	0	
							OFF	OFF	ON	1	
ON		Enable	Seagate	DDS	Enable	All	OFF	ON	OFF	2	
							OFF	ON	ON	3	
							ON	OFF	OFF	4	
							ON	OFF	ON	5	
							ON	ON	OFF	6	
							ON	ON	ON	7	

Figure 9. Dip Switch Default Settings

If you need to change any of the factory-default settings, you must first power-cycle the drive by turning it off and then on again, or a SCSI Bus Reset command must be received for the new switch settings to take effect.

If the default settings are correct for your system, go to: "Mounting the Drive" on page 27.

Otherwise, refer to the appropriate following section, make the changes, then go to: "Mounting the Drive" on page 27.

SCSI Device Address (S1, S2, S3)

The three switches S1, S2 and S3 correspond to the SCSI device address identification bits 0 (LSB) through 2 (MSB), respectively.

The default setting is SCSI device address 0 (S1 through S3 = OFF).

Be sure that no other device on the SCSI bus has the same SCSI address.

Media Recognition System (MRS) (S4)

S4 = ON disables the MRS check
S4 = OFF enables the MRS check

The default is MRS disabled (S4 = ON).

If S4 is ON, the drive writes or reads both MRS and non-MRS 4-mm media. If S4 is OFF, the drive only writes to MRS media. The drive reports a check condition if the media is nondata grade. The Sense Key is 07, Data Protect. The additional Sense Code and qualifier is 30/00, incompatible media installed.

Parity Check Enable/Disable (S5)

The S5 switch enables or disables parity checking for the SCSI bus.

The default is parity disabled (S5 = OFF).

S5 = ON enables parity checking
S5 = OFF disables parity checking

DDS Pass-Through Mode Enable/Disable (S6)

The S6 switch enables or disables DDS pass-through mode. The default is DDS pass-through mode disabled (S6=OFF).

S6 = ON enables DDS pass-through mode
S6 = OFF disables DDS pass-through mode

If you are using the DIP switches to set the DDS pass-through mode, move the DDS pass-through jumpers on the jumper block to the OFF position.

When S6 is OFF, DDS-DC data compression is ENABLED during writing.

When S6 is ON, DDS-DC data compression is DISABLED. During a read operation, compressed data is always decompressed, regardless of the position of S6.

The function of the S6 switch can be overridden by the proper SCSI *Mode Select* command issued from the host computer. Regardless of the position of S6, the Mode Select command can independently enable or disable data compression.

Inquiry String (S7)

The S7 switch is used to select the SCSI inquiry string. The default setting (S7=ON) enables the Seagate inquiry string. You can set it to Archive to provide compatibility with older backup software.

S7 = ON enables Seagate inquiry string
S7 = OFF enables Archive inquiry string

Power-on Self-Test Mode Enable/Disable (S8)

The S8 switch enables or disables execution of power-on self-test (POST) diagnostics when the drive is first powered on. When ON, the drive responds to SCSI commands only after successful completion of the test (about 5 seconds).

The default is power-on self-test mode disabled (S8 = OFF).

S8 = ON enables power-on self-test mode
S8 = OFF disables power-on self-test mode

Switches 9 and 10

These switches are reserved and should not be used.

Setting the Jumpers

The jumper block on the Scorpion 24 provides additional access to settings for SCSI ID, hardware data compression (HDC), enabling of the active terminator and termination power.

For the SCSI ID jumper block settings to take effect, switches S1, S2 and S3 on the switchbank must be in the OFF position.

Figures 10 and 11 illustrate the location of the jumper block for internal drives.

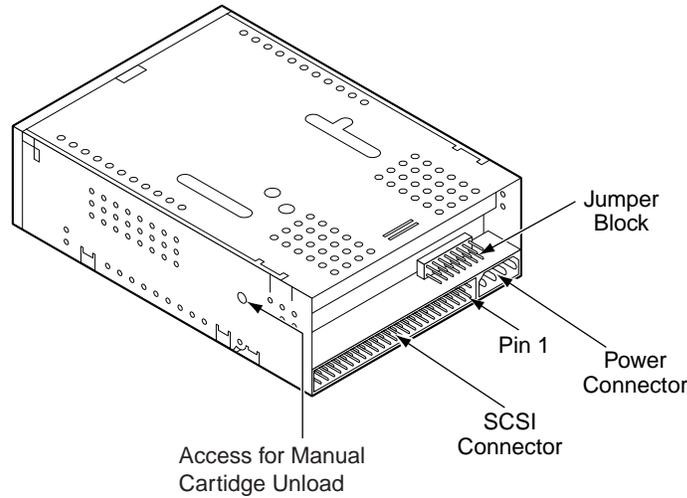


Figure 10. Location of Jumpers for Internal Model

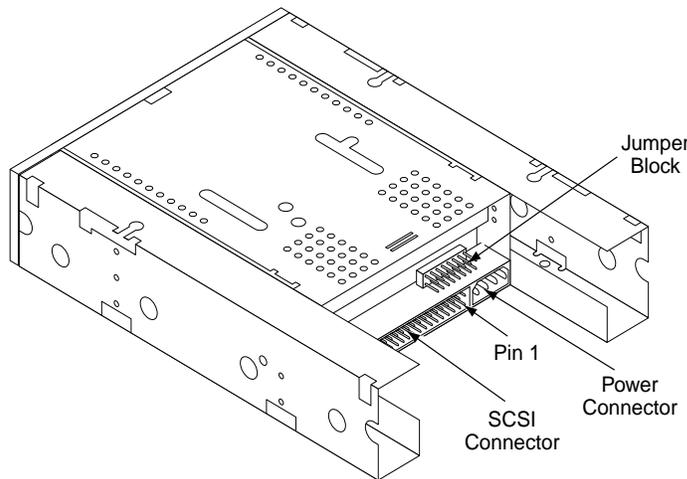


Figure 11. Location of Jumpers for Internal Model with Rails

Figure 12 shows the jumper configurations for the various SCSI device addresses (IDs) and for the other options.

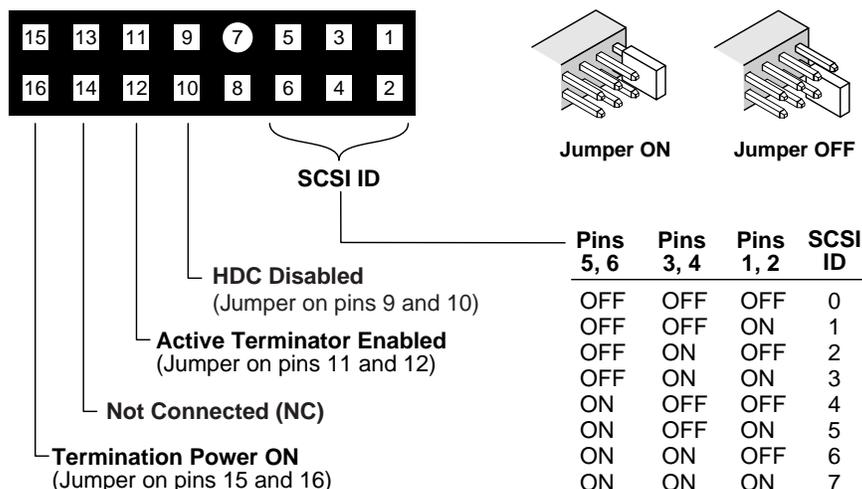


Figure 12. Jumper Configurations

If you need to change any of the factory-default settings, you must first power-cycle the drive by turning it off and then on again, or a SCSI Bus Reset command must be received for the new switch settings to take effect.

If the default address setting ID = 0 is correct for your system and you do not want to change any other options, go to "Mounting the Drive" on page 27.

Otherwise, refer to Figure 9 on page 22 and the appropriate following section, make the changes and then go to "Mounting the Drive."

SCSI Device Address Jumpers

The three jumper locations for ID = 0, ID = 1 and ID = 2 correspond to the SCSI device address identification bits 0 (LSB) through 2 (MSB), respectively.

The default setting is SCSI device address = 0.

Be sure that no other device on the SCSI bus has the same SCSI address.

Hardware Data Compression

Hardware data compression (HDC) is set by either using Switch S6 on the switchbank or by using the jumper block.

The default setting is HDC enabled (no jumper on pins 9 and 10). Placing a jumper on pins 9 and 10 overrides the switchbank setting and disables HDC.

As stated earlier, HDC can also be selected by the proper SCSI Mode Select command issued by the host computer.

Active Terminator

The Scorpion 24 drive provides a jumper-selectable active terminator feature as a substitute for terminator resistor packs. Termination is required if the drive is the only device on the SCSI bus or in the event that the drive is the last device on the bus.

The active terminator option is disabled as the factory-default.

If you need to have an active terminator for the drive, place a jumper across pins 11 and 12.

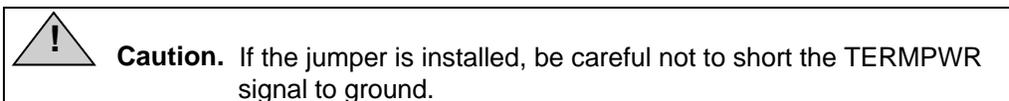
Terminator Power

The Scorpion 24 drive also provides jumper-selectable terminator power. You can enable +5-volt terminator power if needed for terminators or other SCSI devices through a jumper placement.

The factory-default for the Scorpion 24 drive is with terminator power disabled.

To enable terminator power, place the jumper shunt across pin 15 and 16 as shown in Figure 12 on page 25.

Be sure the jumper is firmly in place.



The Scorpion 24 also contains a terminator power fuse to prevent damage to drive components in case the terminator power is shorted. The terminator power fuse is located beside the terminator power jumper.

In the event that the fuse has blown to prevent damage to the drive, please return the drive to the nearest Seagate authorized repair facility for replacement.

Mounting the Drive

You can install the internal drives in three different orientations: one horizontal (eject button right) and two vertical (eject button up or eject button down).

The internal drive chassis contains threaded mounting holes for M3.0 metric screws. The maximum length for the M3.0 metric screws is 4 mm. Four are located on the bottom and five are on each side of the frame. See Figure 13 for details.

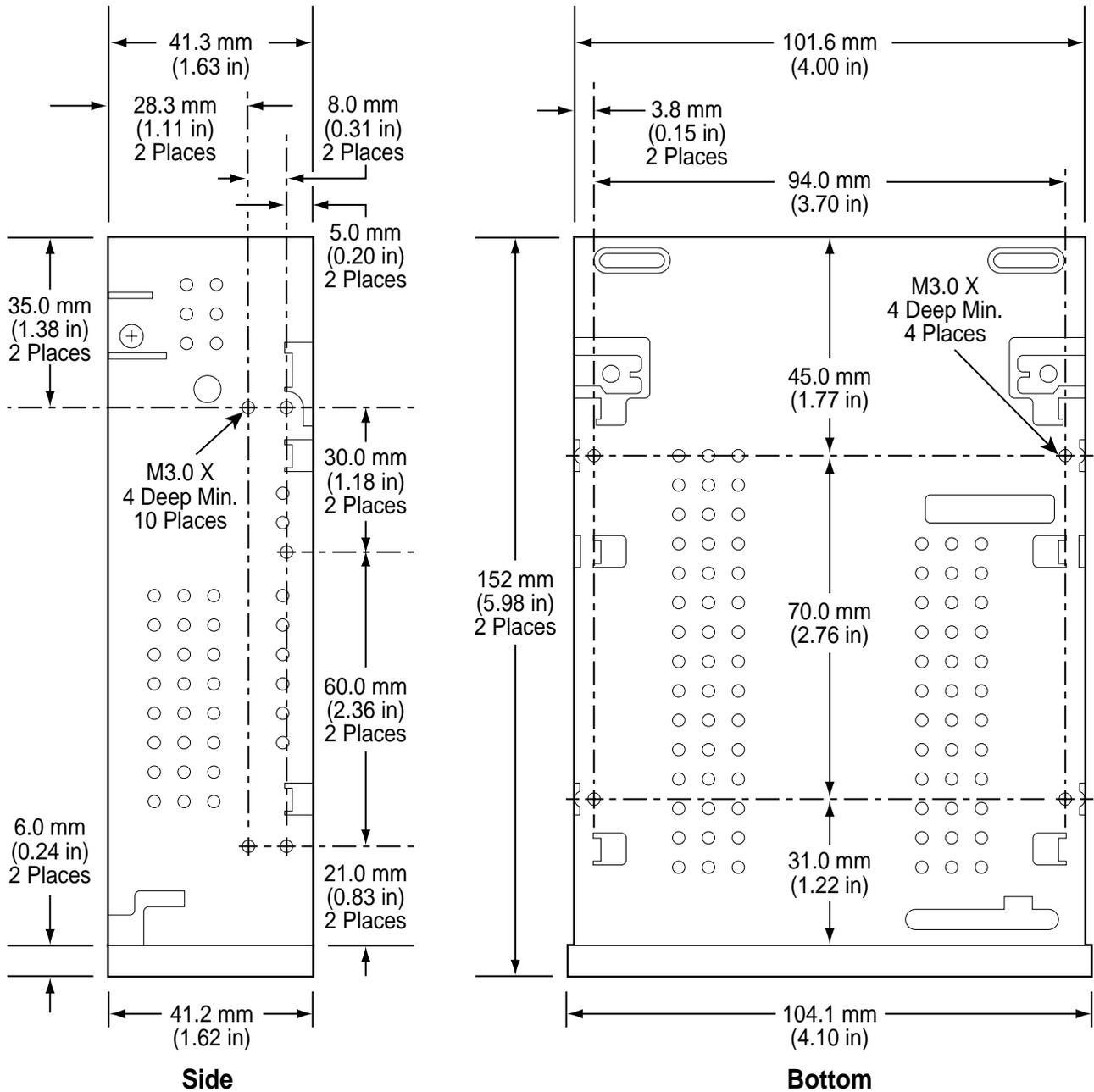


Figure 13. Mounting Hole Locations (Internal Drive without Rails)

The chassis for the internal drive with rails contains threaded mounting holes for M3.0 metric screws. The maximum length for the M3.0 screws is 4 mm. Four are located on the bottom and six are on each side of the frame. See Figure 14.

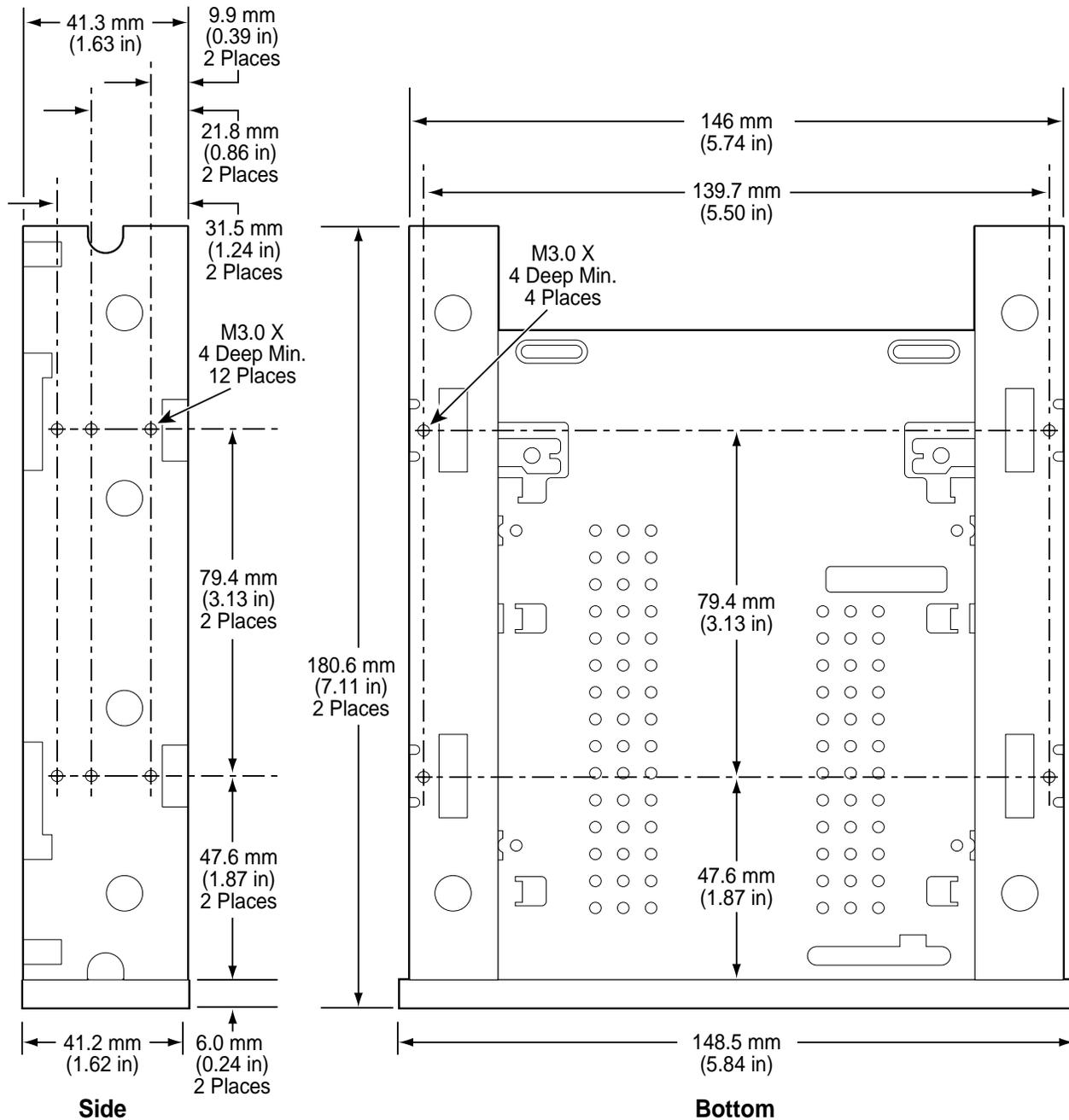


Figure 14. Mounting Hole Locations (Internal Drive with Rails)

Completing the Power and Interface Connections

The power and interface connectors for the internal models are located at the back of the drive unit.

Figure 10 illustrates these connections for the 3.5-inch internal drive. Figure 11 illustrates these connections for the 5.25-inch internal drive with rails.

Note. Turn off all power before inserting connectors.

1. Connect the SCSI cable to the SCSI connector at the rear of the drive. Pin 1 on the SCSI connector is to your right as you look at the back of the drive. (See Figures 10 and 11.) Your SCSI cable should be color-coded with Pin 1 highlighted by a color strip.
2. Make sure you connect Pin 1 on the cable to Pin 1 on the drive. Failure to do so may make the drive inoperative.
3. Connect a power cable from the host system to the power connector on the drive.

The recommended *power mating connector* requires an AMP 1-48024-0 housing with AMP 60617-1 pins or equivalent.

Installing External Drives

The compact external drive connects as a turnkey subsystem to the computer. The drive is operational in either a vertical or horizontal orientation.

The following configuration is the standard default setup:

- The drive writes or reads both MRS and non-MRS 4-mm media.
- Parity is disabled.
- DDS-DC data compression is enabled.
- The power-on self-test (POST) diagnostics of the drive are disabled.
- Terminator power is supplied to the SCSI bus.

Installing the external unit consists of a few easy steps:

1. Select the SCSI address.
2. Complete the interface connection.
3. Complete the power cord connection.

Selecting the SCSI Address

The rear panel of the external drive contains the SCSI address selection push switch, the two interface connectors, the ON/OFF switch and the power cord connection. Figure 15 illustrates the rear panel.

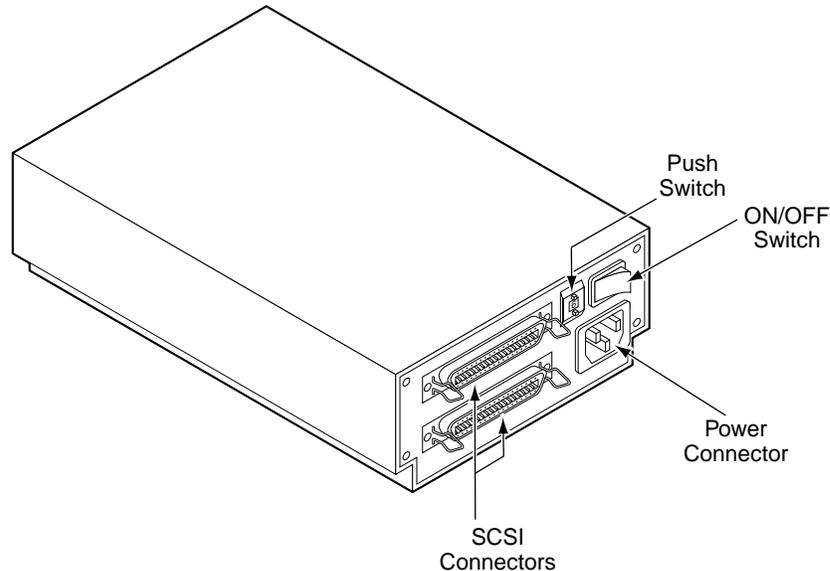


Figure 15. Rear Panel (External Model)

Locate the SCSI address push switch. Select the SCSI address for the drive by pressing the (+) or (-) button until the desired address (0 through 7) appears in the window.

If you need to change any of the factory-default settings, you must first power-cycle the drive by turning it off and then on again, or a SCSI Bus Reset command must be received for the new switch settings to take effect.

Completing the Interface Connection

The external drive provides two SCSI connectors to allow daisy-chain connections. (See Figure 16.) Either connector can connect to the host computer or to any other SCSI device in the daisy chain.

Note. Turn off all power before connecting cables and the terminator.

- When the drive is either the only drive in the chain or the last drive in the chain, a single interface cable is attached to one connector, and a terminating plug is installed in the other connector. (Seagate part number 38-9-7400000)
- When the drive is within the chain, the interface cable from the preceding device is connected in one connector, and an interface cable is also connected from the other connector to the following device. In this case, no termination is required.

Introduction

This chapter describes important operational procedures for the Scorpion 24 drive. It covers the following topics:

- Data compression operation
- Front panel LED operation
- Loading and unloading a cartridge
- Using a blank cartridge
- Using a cartridge that contains data
- Loading revised firmware through Seagate firmware cartridges

Data Compression Operation

Default operation for the Scorpion 24 drive is to have data compression enabled—the drive automatically compresses all data written to tape and decompresses all compressed data read from tape.

The degree of compression varies due to the type of data being processed.

Data with high degrees of redundancy, such as structured database files or graphics files, can be compressed most efficiently, often at a ratio of 2:1 or more. Data with little redundancy, such as executable programs, can be compressed the least.

The SCSI *Mode Select* command can switch the drive into compressed or uncompressed mode for writing data regardless of the position of the jumper position. When reading, the drive automatically selects compressed or uncompressed mode, depending on the data that is read.

On internal models, a jumper on the rear panel can also be used to enable or disable data compression. See Chapter 3 for more information.

Front Panel LED Operation

The front panel of the Scorpion 24 drive contains two rectangular LEDs. The yellow rectangular LED indicates the drive status, and the green rectangular LED indicates the cartridge status. These two indicators provide operating information for normal conditions and error conditions.

The *drive status LED* indicates the following conditions:

- When ON (lit), the drive is reading or writing the tape. (SCSI or drive activity is present.)
- When flashing rapidly, a hardware fault has occurred. If this situation occurs immediately after power-on and you have enabled the power-on self-test through a jumper setting, the power-on self-test may have failed. In that case, the drive will not operate.

Note. During a SCSI Prevent Media Removal command, the LED is always ON.

Note. Do not push the eject button while the yellow drive status LED is ON. If you do, the operation in progress is aborted and the cartridge ejected, possibly causing a loss of data.

The *cartridge status LED* indicates the following conditions:

- When ON (lit), a cartridge is inserted and the drive is operating normally.
- When flashing slowly, a cartridge is inserted but is generating excessive media errors beyond a predefined error threshold. This signal is a warning only and does not indicate a loss of data.

Whenever the cartridge status LED flashes slowly to warn of excessive media errors, the operator should clean the drive heads using an approved cleaning cartridge (such as the Seagate Model M7301).

If the LED continues to flash or flashes while ejecting a cartridge, use a new cartridge for future writes as a precaution.

Note. As routine maintenance, the drive heads should be cleaned after every 25 hours of operation. Even though the Scorpion 24 drive has an internal cleaning mechanism, a regular cleaning routine helps reduce errors due to environmental contaminants such as dust, carpet fibers or airborne debris.

- When flashing rapidly, the drive could not write the tape correctly (maximum rewrite count exceeded). The *WRITE* operation failed.

First, clean the drive heads using an approved cleaning cartridge, such as the Seagate Model M7301. If the LED continues flashing, use a new cartridge for future writes.

Audio Mode Indicator

The cartridge status LED flashing in conjunction with the drive status LED indicates that a prerecorded audio cartridge is inserted and is playing automatically.

External Power LED

The round, green LED on the external drive illuminates when power is applied to the drive.

The following table summarizes the operation of the front-panel LEDs. See the previous explanations to remedy fault conditions.

LED	Action	Meaning
Yellow	ON (lit)	The drive is reading or writing the tape.
Yellow	Flashing rapidly	A hardware fault occurred.
Green	ON (lit)	A cartridge is inserted and does <i>not</i> generate excess errors.
Green	Flashing slowly	A cartridge is inserted but generates excessive errors beyond a predefined error threshold. (Warning only) <i>Use a DDS cleaning cartridge to clean the heads.</i>
Green	Flashing slowly (with yellow LED flashing)	A prerecorded audio cartridge is inserted and is playing automatically.
Green	Flashing rapidly	The drive could not write the tape correctly. (Error) <i>Use a DDS DAT cleaning cartridge to clean the heads.</i>
Green, round (External drives)	ON (lit)	The external drive is powered on.

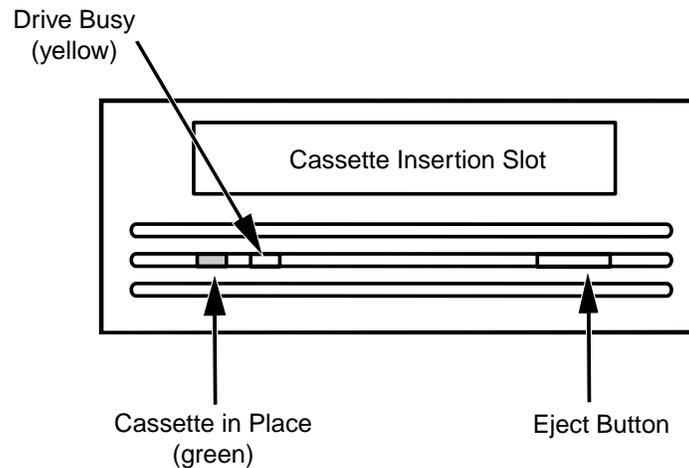


Figure 17. Front Panel—Internal Model

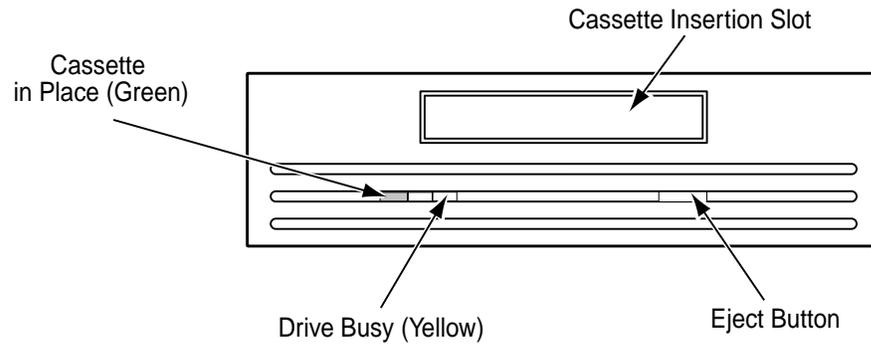


Figure 18. Front Panel—Internal Model with Rails

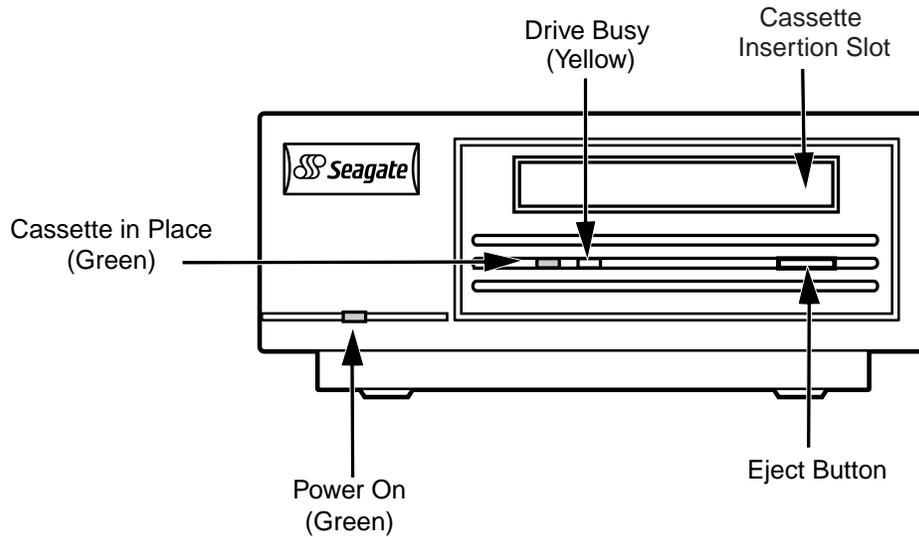


Figure 19. Front Panel—External Subsystem

Loading/Unloading the Cartridge

The cartridge insertion slot on the front panel of the Scorpion 24 drive provides easy access to the drive.

This section explains loading and unloading a cartridge under normal operating conditions. It also explains the manual procedure for removing a cartridge abnormally lodged in the drive. Under a few exceptional conditions—such as a power outage, you may need to manually unload a cartridge.

Loading/Unloading a Cartridge (Normal Operation)

The Scorpion 24 drive has a front-loading cartridge insertion mechanism that allows an operator to easily load the cartridge. Insert the cartridge with the arrow on the top of the cartridge entering the slot first. Push against the middle part of the cartridge opening until it is fully recessed into the cartridge insertion slot.

Figure 20 illustrates cartridge loading (internal drive shown).

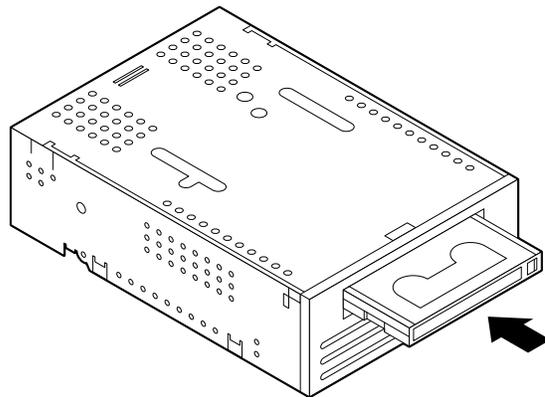


Figure 20. Cartridge Loading (Internal DAT Drive)

Unload the cartridge by pressing the eject (tape unloading) button on the front panel. (See Figures 17, 18 and 19 for the location of the Scorpion 24 eject button.)

After you press the eject button, the drive updates the system log, rewinds the tape and then ejects the cartridge. You can then easily remove it from the drive.

Note. The time between pressing the eject button and cartridge ejection may be several seconds. Do not power down the external drive or the internal drive host computer until the unload operation has completed and the cartridge has fully ejected. Powering down before completion may interfere with the system log update or may render the tape unreadable.

Unloading a Cartridge (Manual Operation)

If a power outage occurs while a cartridge is loaded or the automatic unload procedure previously explained fails, you may want to manually unload a cartridge from the drive. The following steps outline the manual cartridge unloading and removal procedure.

1. Remove the power connections. For internal models, disconnect the power connection with the host computer. For the external model, remove the power cord from the drive.
2. Disconnect the SCSI cable from the unit.
3. For internal models, remove the drive from the computer.
4. Remove the top cover by removing the two screws at the top edge near the rear of the unit (one on each side). (See A in Figure 21.) Save the screws in a safe place. Then remove the front bezel by pulling out on the top of the bezel at the indentation. (See B in Figure 21.)

For the internal model with rails, remove the mounting rails by removing the four screws near the lower edge of the unit (two on each side) that are accessed through holes in the side of each rail. Next, remove the drive's top cover by removing the two screws at the top edge near the rear of the drive (one on each side). Save the screws in a safe place. (See A in Figure 21.) Then remove the front bezel by pulling out on the top of the bezel at the indentation. (See B in Figure 21.)

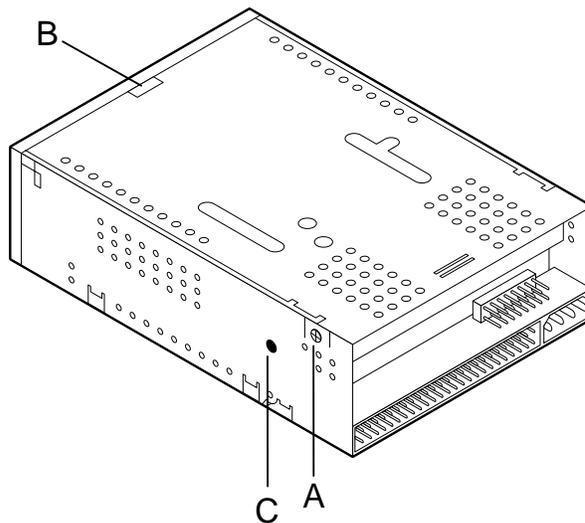


Figure 21. Locations on Drive

5. Turn the unit upside down and remove the four screws (two screws on each side) that attach the external cover to the chassis unit. Remove the exterior cover and retain the screws. On the drive unit inside the chassis, remove the top cover by removing the two screws at the top edge near the rear of the unit (one on each side). (See A in Figure 21.)
6. Insert a small (precision) screw driver in the hole on the right side of the drive near the rear and turn the mode motor shaft clockwise. (See C in Figure 21.)



Caution. Do *not* turn the mode motor shaft counterclockwise. Turning the shaft counterclockwise may damage the mode gear.

Continue turning the mode motor shaft. As you turn the shaft clockwise, you can see the cartridge slowly rise. The metal track slowly moves forward, changing the cartridge position as you continue turning the shaft clockwise.

Continue turning the shaft until the cartridge rises and then protrudes from the slot and “clicks” free. Remove the cartridge.

7. Replace the drive's top cover and secure it with the two screws that you removed.
8. For internal models, replace the front bezel (internal models) by angling the two plastic feet at the bottom of the bezel inward and aligning them with the two holes on the bottom of the unit. Then snap the top of the bezel into place.

For the internal model with rails, reattach the rails using the screws that you removed.

For the external model, reassemble the exterior cover.

9. Reinstall internal models in the computer and complete all connections. Reconnect the external model to the computer.

Using a Blank Cartridge

When you insert a blank tape cartridge into the drive for the first time, it is automatically initialized. The drive first detects that the tape is blank and then initializes the tape when it receives a command that initiates a write operation.

Note. Initializing the tape takes about 30 seconds. Ejecting the cartridge before the initialization is complete causes the procedure to abort. The initialization then restarts from the beginning the next time a Write command is received.

The following steps outline a typical sequence for using a blank cartridge.

1. Gently push the blank cartridge into the cartridge insertion slot on the front panel with the arrow on the top side of the cartridge entering the opening first. (See Figure 20.)

After the cartridge is partially inserted, the drive mechanism automatically completes the cartridge insertion process and properly positions the tape within the drive.

The yellow and green rectangular LEDs on the front panel turn ON as the drive checks the cartridge to determine its state (blank, write-protected, prerecorded audio, firmware update, etc.) and then positions to the data area, which typically takes about 10–12 seconds.

2. Start the software application and issue a command.

For example, if you want to back up a file, issue the appropriate command or make the appropriate menu selections from the backup application software. The drive begins initializing the tape before completing the backup (WRITE) operation.

3. After completing the backup and the yellow rectangular LED on the front panel is OFF, push the eject (tape unload) button on the front panel to remove the cartridge.

The drive buffer then empties to tape, the tape rewinds and the system log is updated.

After being ejected, the cartridge rests in the cartridge insertion slot in a half-way position for easy removal.

Using a Cartridge Containing Data

The sequence for writing a cartridge that already contains data is virtually the same as the blank cartridge sequence with the exception that the cartridge initialization process is not necessary.

A brief delay occurs as the cartridge is inserted while the drive identifies the cartridge type and state, and then positions to the data area.

Loading Revised Firmware Using Seagate Firmware Cartridges

Flash Memory

Another technological advancement incorporated into the Scorpion 24 drive is flash memory, which is useful if the drive's SCSI firmware needs to be upgraded. With the permanently installed, electrically upgradeable flash memory, revised SCSI firmware for the drive can be loaded using any one of three methods: 1) Seagate OEM firmware cartridges (see Chapter 4); 2) through the host SCSI bus; and 3) through the drive serial port (see Chapter 8).

The flash memory feature enables qualified OEMs who need to revise Scorpion 24 SCSI firmware to do so quickly and easily. Flash memory also prolongs the life cycle of a drive because many new techniques—such as increasing the capacity of the drive through support for longer tapes—may require only a firmware upgrade.

Firmware Download Process

To load a firmware upgrade tape, follow these steps.

1. Power on the host system with the Scorpion 24 drive installed.
2. Make sure that there are no applications running that may try to communicate to the drive during the firmware upgrade process. Close any such applications before inserting the firmware upgrade cartridge.
3. Insert the firmware upgrade cartridge.



Caution. Once the firmware upgrade cartridge is inserted into the drive, it is important that no power interruption occurs while the firmware is loading. *Do not power off the drive.* If a power interruption occurs, the firmware may not be loaded correctly, and the drive may not operate properly.

4. The drive automatically recognizes the firmware upgrade cartridge and begins downloading the firmware from the cartridge into DRAM.
5. The drive ejects the firmware upgrade cartridge as soon as the firmware has been completely downloaded into DRAM and the LEDs begin blinking with a progressive pattern. When the blinking pattern stops, the firmware upgrade operation is complete.



Caution. Do not power down the host system or disconnect power to the drive until you have completed step 6—this may render the drive inoperative.

6. Power down the system and reboot. The new firmware is immediately active and operational.

Note. At this time, we recommend that you power cycle the drive to refresh any new parameter information and to execute the power-on self-test (POST) to ensure proper unit functionality.

Firmware upgrade cartridges are available only to qualified Seagate OEM customers. Contact your Seagate sales representative for information.

Introduction

Scorpion 24 drives feature a single-ended SCSI-2 interface. Scorpion 24's SCSI-2 interface allows for communication between the host computer and the Scorpion 24 drive. The Scorpion 24 SCSI-2 interface conforms to requirements outlined in ANSI X3.131, 199x.

This chapter summarizes the SCSI-2 message codes, status codes and commands.

Refer to chapter 3 for specific SCSI cabling and connection information.

Refer to *Seagate's DAT Tape Drive and Autoloader SCSI Manual* (part number 10002663-00x) for detailed developer information relative to SCSI implementation.

SCSI-2 Interface

The SCSI-2 interface for the Scorpion 24 drive conforms with the ANSI X3.131 1994 standard. The following three tables list the message codes, status codes and commands for this interface.

SCSI Message Codes

Code	Description	Direction¹
00 _H	Command Complete	In
02 _H	Save Data Pointer	In
04 _H	Disconnect	In
05 _H	Initiator Detected Error	Out
06 _H	Abort	Out
07 _H	Message Reject	In/Out
08 _H	No Operation	Out
0A _H	Linked Command Complete	In
0B _H	Linked Command Complete with Flag	In
0C _H	Bus Device Reset	Out
80 _H	Identify (No Disconnect/Reconnect)	In/Out
C0 _H	Identify (Disconnect/Reconnect)	In/Out
01 _H ²	Extended Message	In/Out

1. Direction: In = Drive to host; Out = Host to Drive

2. Supports only one extended message: Synchronous Data Transfer Request

SCSI Status Codes

Bits	4-bit Status Code					Definition
	4	3	2	1	0	
	0	0	0	0	X	Good Status
	0	0	0	1	X	Check Condition
	0	1	0	0	X	Busy
	1	0	0	0	X	Intermediate Status
	1	1	0	0	X	Reservation Conflict

SCSI Commands

Code	Type	Command
00 _H	M	Test Unit Ready
01 _H	M	Rewind
02 _H	V	Request Block Address
03 _H	M	Request Sense
05 _H	M	Read Block Limits
08 _H	M	Read
0A _H	M	Write
0C _H	V	Seek Block
10 _H	M	Write Filemarks
11 _H	M	Space
12 _H	M	Inquiry
13 _H	O	Verify
15 _H	M	Mode Select
16 _H	M	Reserve Unit
17 _H	M	Release Unit
19 _H	M	Erase
1A _H	M	Mode Sense
1B _H	O	Load/Unload
1C _H	O	Receive Diagnostic Results
1D _H	M	Send Diagnostic
1E _H	O	Prevent/Allow Medium Removal
2B _H	O	Locate
34 _H	O	Read Position
3B _H	O	Write Data Buffer
3C _H	O	Read Data Buffer
40 _H	O	Change Definition
4C _H	O	Log Select
4D _H	O	Log Sense

M = Mandatory Command
E = Extended Command

O = Optional Command
V = Vendor-Unique Command

ANSI X3.131, 199x Conformance Statement (SCSI-2)

General Features

- Disconnect/reconnect, arbitration (required in SCSI-2)
- Single-ended drivers
- Termination power supplied to cable (jumper option)
- Supports both single and multi-initiator systems
- Fixed and variable block transfer lengths
- Hard reset
- Synchronous data transfers
- Parity implemented (switch option)
- Space blocks, filemarks and EOD
- Supports third-party reservation
- Log Sense and Log Select for managing soft error reporting
- MODE SENSE/SELECT page to control and report operation of data compression in sequential access devices and to read from and write to the configuration EEPROM

Typical System Configurations

The SCSI standard provides support for up to eight SCSI addresses or IDs. These IDs refer to host adapters or peripheral devices such as printers, magnetic discs or tape drives.

Any combination of a single host and up to seven additional SCSI devices can be chained together on a single SCSI cable.

Figure 22 shows a variety of possible SCSI system configurations.

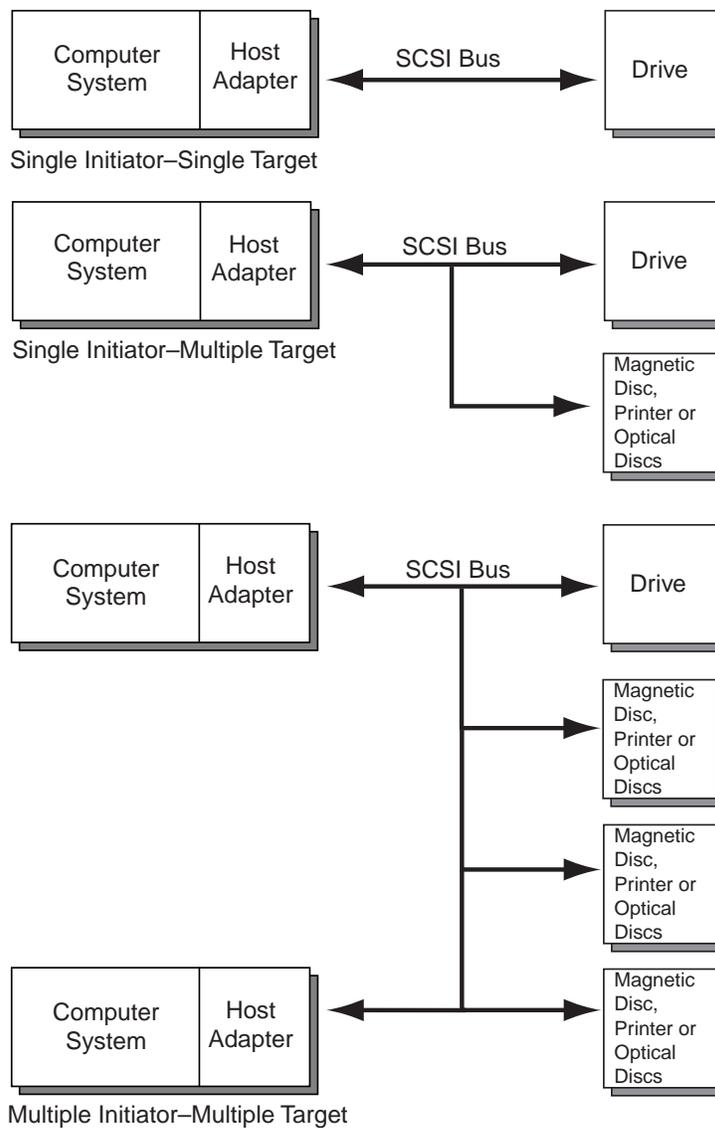


Figure 22. SCSI System Sample Configurations

Introduction to DDS Recording Format Standards

One of the major benefits in DDS technology is in the consistency and strength of the format standards.

Precise recording format standards provide the basis for well-defined interchange requirements. DDS format standards define physical cartridge case requirements, physical and electrical requirements for the unrecorded tape, format requirements for tape interchange, measurement methods, and test-environment definition and provide measurable conformance requirements. With this common technical basis for interchange, vendors can pursue additional technical features or solutions to differentiate themselves in the market.

The strong standards associated with DDS technology encourage multiple drive and media vendors worldwide to participate in the technology. Their participation provides the end-user with a wide range of choices for high-capacity, high-performance data storage.

While each of the DDS formats has a unique physical and logical format structure, the purpose of this chapter is to describe the DDS-3 format.

DDS-3 Tape Format

The smallest collection of data supported by the DDS-3 format is a *record*. A record is the smallest discrete collection of data that can be supplied by the host to the Scorpion 24 drive for processing and recording to tape. Conversely, a record also refers to the smallest collection of data readable by the tape drive from tape, for reprocessing and transfer back to the host system.

Two types of records are supported: *processed records* and *unprocessed records*.

A record may contain processed records, unprocessed records or both. A record may also contain *separator marks*.

Note. Separator marks as described in the DDS-3 standard are similar to the terms set mark and file mark as used in other recording format standards. Typically separator 1s refer to file marks and separator 2s refer to set marks.

Entities are defined as logical objects that contain processed records.

Entities, unprocessed records and separator marks are collected into *groups*. Groups are processed through a series of transformations including randomizing, interleaving, blocking, generating and inclusion of ECC, and translation of data bytes to channel bits before recording to tape.

Each group is recorded on a set of *tracks*. User data, separator marks and associated information are recorded in the *main data zone* of each track. Group content, track location and track content information is recorded in the headers of fragments, which are in the main data zone.

Basic Groups

Data from the host system to be recorded to tape is grouped into *basic groups* of 384,296 bytes each. For location purposes on the tape, each individual basic group is identified by a number beginning at 0, running consecutively thereafter. Within each basic group, the individual bytes are also identified, again with a consecutively running number beginning at 1 and running through 384,296.

Data and separator marks transferred from the host system are grouped into an individual basic group according to the following structure:

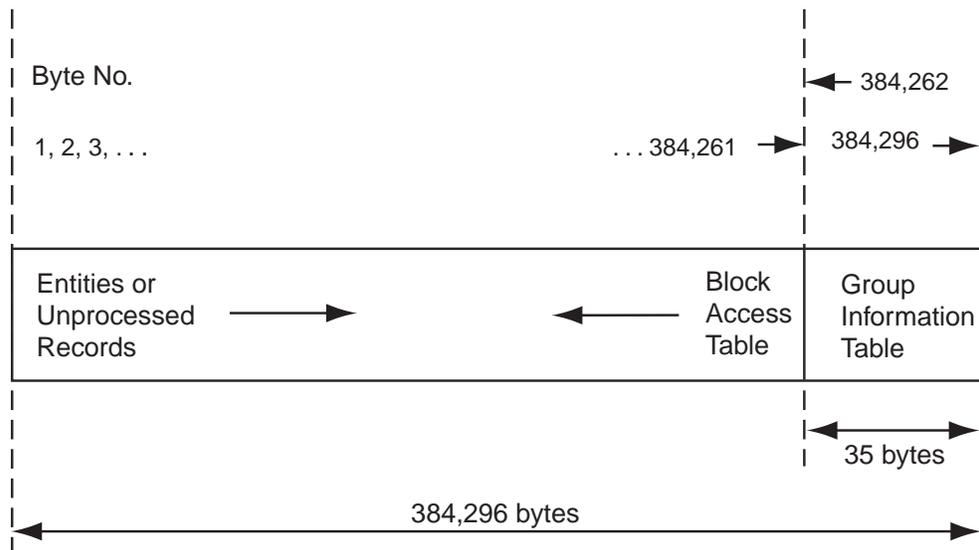


Figure 23. Structure of a Basic Group

As seen in Figure 23, in addition to entities or unprocessed records, the structure of a basic group includes a *group information table (GIT)* and a *block access table (BAT)*. The group information table always occupies the last 35 bytes of the basic group.

Entities

Each entity includes an entity header and a processed record sequence. The header is 8 bytes long and precedes the processed record sequence. By definition, all processed records contained within an entity go through the same processing algorithm; additionally this processing takes place only on unprocessed records of equal length.

Entities can span basic groups as long as the header and the first 8 bits of the processed record sequence are within the same basic group. Where an entity has spanned multiple basic groups, the individual parts of the entity within the basic groups are referred to as *partial entities*.

Subgroups

When the formation of a basic group is complete, the next step is to split the basic group into 22 *G1 subgroups* of 17,468 bytes numbered from 0 through 17,467. Each *G1 subgroup* is assigned a consecutive number from 1 through 22.

The bytes of each *G1 subgroup* are then randomized to form a *G2 subgroup* of equal size.

Each *G2 subgroup* is then rearranged to form a *G3 subgroup* of 17,472 bytes. The first 8,734 bytes are grouped into Track A of the *G3 subgroup*; the remaining 8,734 bytes are grouped into Track B of the same *G3 subgroup*.

Finally, each *G3 subgroup* is transformed into a *G4 subgroup* that contains an array sign, a fragment number and a serial number. Each *G4 subgroup* consists of two arrays of 96 fragments each. Each fragment is transformed into a *main data fragment*. Each main data fragment consists of a fragment ID, an area ID, a frame number, subcode bytes and fragment header parity bytes.

Basic Group Transformation Summary

Through the transformation process described above, each basic group is transformed into 4,224 main data fragments before recording to tape.

Subcode Information

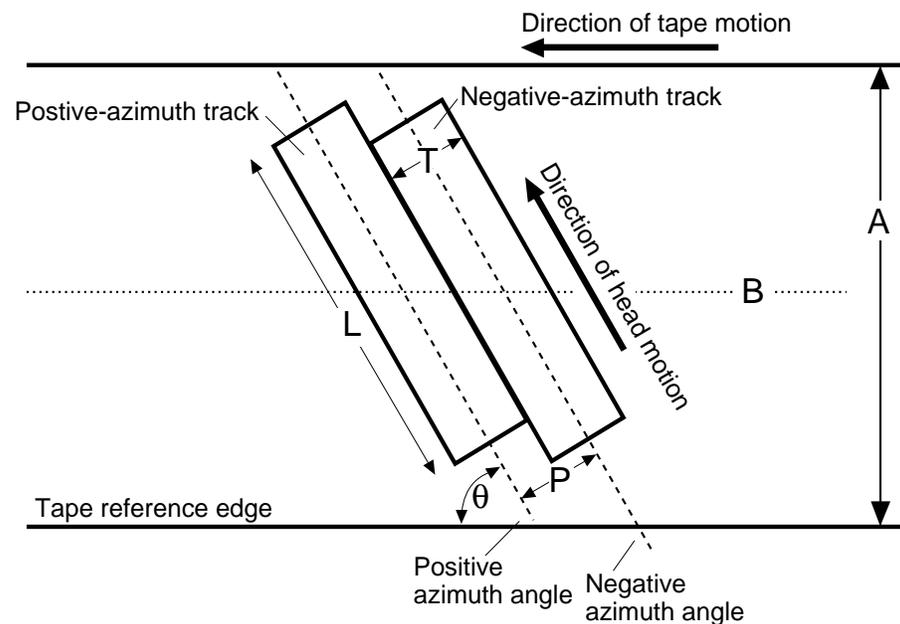
Subcode information specifies the running number of the basic group, the number of separator 1s written since the logical beginning of tape (LBOT), the number of separator 2s written since the LBOT, the number of records written since the LBOT information about track contents and information about the history of the tape.

Subcode Location

Subcode information is written within each main data fragment header.

DDS-3 Track Geometry

The Scorpion 24 DDS-3 drive records to tape in a helical track pattern. This track pattern is dependent upon the relationship of two items: 1) the direction of tape motion and 2) the rotational axis of a pair of record heads located on the tape drive cylinder. One recording head has a positive azimuth angle and the other has a negative azimuth angle. (Chapter 8 of this manual, *Theory of Operations*, further explains details relative to helical scan recording and the head to tape interface.) The direction of tape recording is away from the *tape reference edge*.



Legend:

A – Tape width	L – Track length
B – Ideal tape centerline	P – Track pitch
θ – Track angle	T – Track width

Figure 24. Track Configuration

DDS-3 Track Specifications

Parameter	Specification
Average Track Pitch	9.053 μm \pm 0.045 μm
Variations of Track Pitch	2% maximum
Track Width	
Nominal	9.053 μm
Measured	9.1 μm \pm 1.8 μm
Track Angle	6° 22' 39.6"
Track Length	23.521 mm \pm 0.047 mm
Ideal Centerline	1.900 mm from the Tape Reference Edge
Azimuth Angle	
Positive	20° 00' 39.6" \pm 15' 00.0"
Negative	19° 59' 20.4" \pm 15' 00.0"

Recorded Patterns

The host data, which has already been transformed as described in the subgroup section above and is contained within the main data fragments, is translated into channel bits for recording to tape. The DDS-3 format specifies that each 8-bit byte of the data found in the main data fragments is translated into a 10-bit pattern. These 10-bit patterns are referred to as channel bits.

Format of a Track

Each individual track is made up of two *margin zones*, a *preamble zone* and a *main data zone*.

Track Format

Zone	Contents	Number of 10-bit Patterns
Margin Zone No. 1	Margin Pattern	640
Preamble Zone	Preamble Pattern	64
Main Data Zone	Recorded Main Data Fragments	12,768
Margin Zone No. 2	Margin Pattern	640

Positioning Accuracy

The DDS-3 specification reflects a tighter requirement for *positioning accuracy* when compared to previous standards.

The DDS-3 standard specifies the position reference point of all tracks to be 1.906 mm from the tape reference edge.

The position reference point of any adjacent 12 tracks, or positional reference point variance, must be within 1.0 μm of the mean position reference point of all tracks within the described continuum.

This compares to a position reference point variance of 6.6 μm as allowed in the DDS-2 format standard.

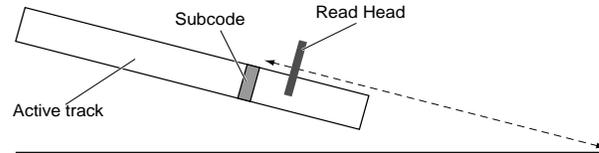
Timing Tracking

Playback tracking in the previous DDS-2 and DDS formats was accomplished through the use of *automatic track following (ATF)*. The ATF method required that special low frequency tracking signals be recorded at both ends of each data track recorded to tape. The ATF method reduced overall format efficiency and also required special analog hardware circuitry to read and process these ATF signals.

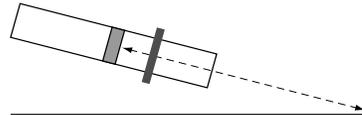
The DDS-3 format departs from the ATF method, using instead, a more sophisticated *timing tracking* system to ensure accurate tracking throughout the tape. timing tracking control is performed within the firmware by calculating the elapsed time from a fixed point in the rotational arc of the head cylinder to a reference point (sync signal or parity signal) recorded within the track area. Advantages of the timing tracking include a 50 percent increase in format efficiency over DDS-2, more accurate tracking due to separate tracking error calculations for each record head and more flexible tracking because tracking can be performed using data detected anywhere along the length of the track.

With timing tracking, capstan servo control is performed by monitoring the time from the cylinder PG signal until the recorded track data begins; that is, until the first sync or parity data is detected.

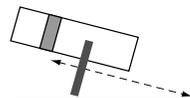
When the playback head is perfectly on track, this time is measured as T_0 . When the head is off track by any amount, the measured time T_1 is longer or shorter than T_0 , depending on whether the tape is moving too fast or too slow. The capstan servo can then use this time difference to correct the tape speed and to bring the heads back on track.



Case 1: The head is off track because the tape is moving too fast. Too much time elapses before the heads read the subcode. To bring the heads on track, the drive automatically slows the tape.



Case 2: The head is on track, and no corrective action is necessary.



Case 3: The head is off track because the tape speed is too slow. Too little time elapses before the heads read the subcode. To bring the heads on track, the drive automatically increases the tape speed.

Figure 25. Timing Tracking

The PG position is a known constant which is based on the fixed mechanical positions of the PG sensors and the heads within the cylinder. These relative positions do not change and can be used as a solid baseline for the timing calculations. Also, because there are separate PG pulses associated with each recording head (A and B), accurate timing tracking can be achieved even under adverse conditions.

To ensure optimum accuracy, a calibration is performed whenever a recorded tape is inserted into the Scorpion 24. This calibration determines the target time against which all succeeding measurements are compared.

Tape Layouts in the DDS-3 Standard

The DDS-3 standard provides for two types of overall tape layouts, single data space tapes and partitioned tapes. The following two sections describe the specific layouts for each.

Layout of a Single Data Space Tape (Single Partition)

The DDS-3 recording format supports both *single data space tape (nonpartitioned)* and *partitioned tape*. You can record a tape as either a single data space tape or as a partitioned tape.

The tape layout for a single data space tape contains six areas: the *device area*, the *reference area*, the *system area*, the *data area*, the *EOD area* and the *post-EOD area*.

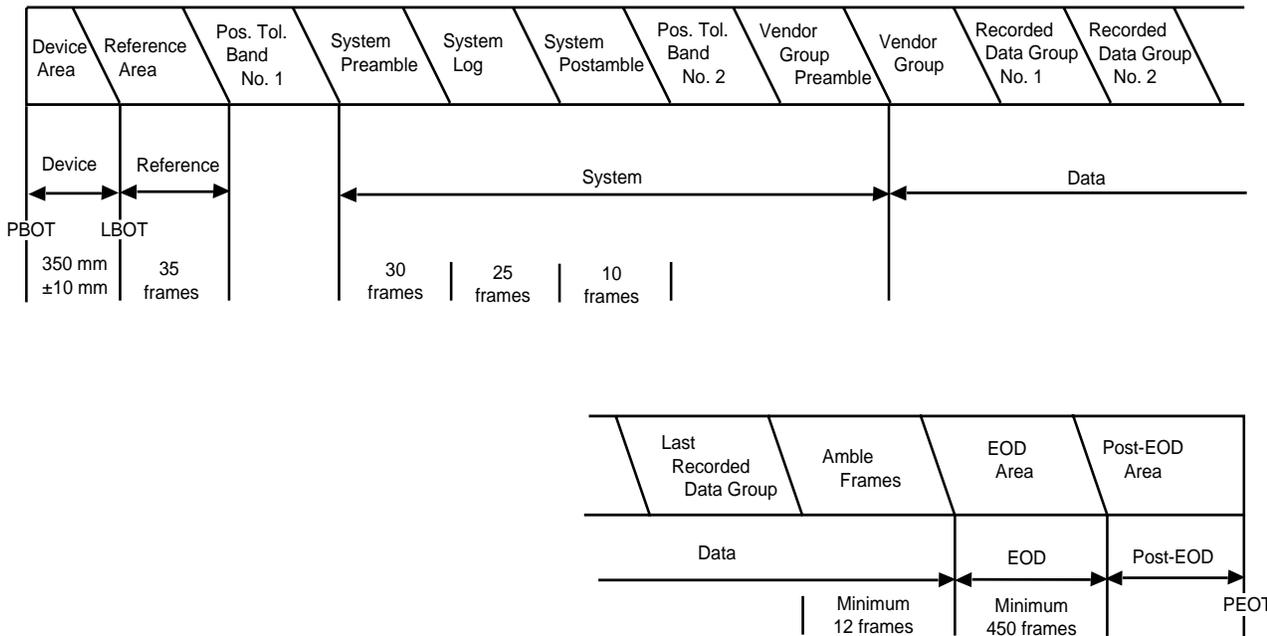


Figure 26. Layout of a Single Data Space Tape

Device Area

The device area is the first area recorded on the tape and extends from the physical beginning of tape (PBOT) to the logical beginning of tape (LBOT). The device area is not used for writing data for interchange. The device area consists of three zones, the *spinup zone*, the *test zone* and the *guard zone*.

The spinup zone consists of the first part of the tape that is wrapped around the cylinder when the tape is inserted into the drive. The next zone, the test zone, is available for read/write purposes. The last zone, the guard zone, is specified as having a minimum length of 9 mm in which no recording is permitted.

Reference Area

The Reference Area is used as the physical reference when updating the *system log* and consists of 35 *tape management frames* starting at the LBOT and having an *absolute frame number* of 1.

System Area

The System Area consists of the *system preamble*, the *system log*, the *system postamble*, *position tolerance band 2* and the *vendor group preamble*.

Data Area

The data area consists of the *vendor group* and one or multiple *recorded data groups*. The vendor group is defined as basic group 0 (refer to the basic group and subgroup information above). Each recorded data group is equivalent to a single basic group.

To ensure the highest possible data integrity, two methods are used.

First, the Scorpion 24 creates ECC3 (error-correction code 3) data, which provides the capability to correct any two bad tracks in a recorded data group. The ECC3 data is derived from the 22 G1 subgroups of each basic group to form a 23rd G1 subgroup.

Second, to guard against normal expected tape defects, the Scorpion 24 uses read-after-write capability to identify frames that have not been recorded correctly to tape (read-after-write is described in detail in Chapter 8, “Theory of Operations”, on page 71). When the drive identifies an incorrectly recorded frame, it is rewritten within a maximum of 7 frames further down the tape. To skip elongated sections of defective spots on tape, the rewrite operation may be repeated up to 255 times.

Appending to Tape

The DDS-3 format provides for *seamless appends* and *nonseamless appends* to tape.

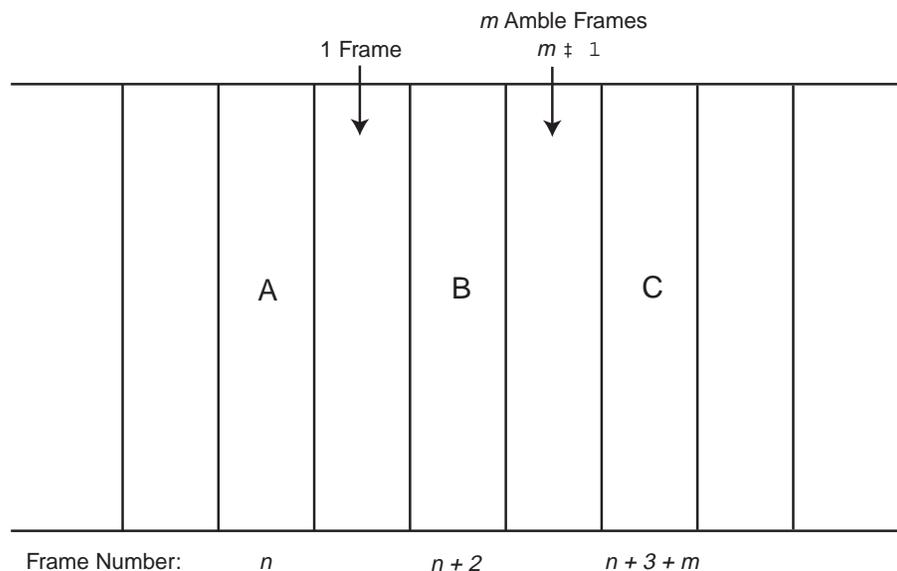


Figure 27. Appending Rules

The following rules are for the DDS-3 format for a seamless append:

1. There should be one frame between Frame A and Frame B. For example, if frame A has an absolute frame number (AFN) of n , then Frame B should have an AFN of $n + 2$.
2. The frame written between Frames A and B should be contiguous with Frame A. For example, no unrecorded space between A and B is permitted.
3. There should be a minimum of one amble frame between Frames B and C. For example, if Frame B has an AFN of $n + 2$, then Frame C should have an AFN of $n + 4$ minimum. No unrecorded space, physical discontinuity or AFN discontinuity or repetition is allowed between frames B and C.

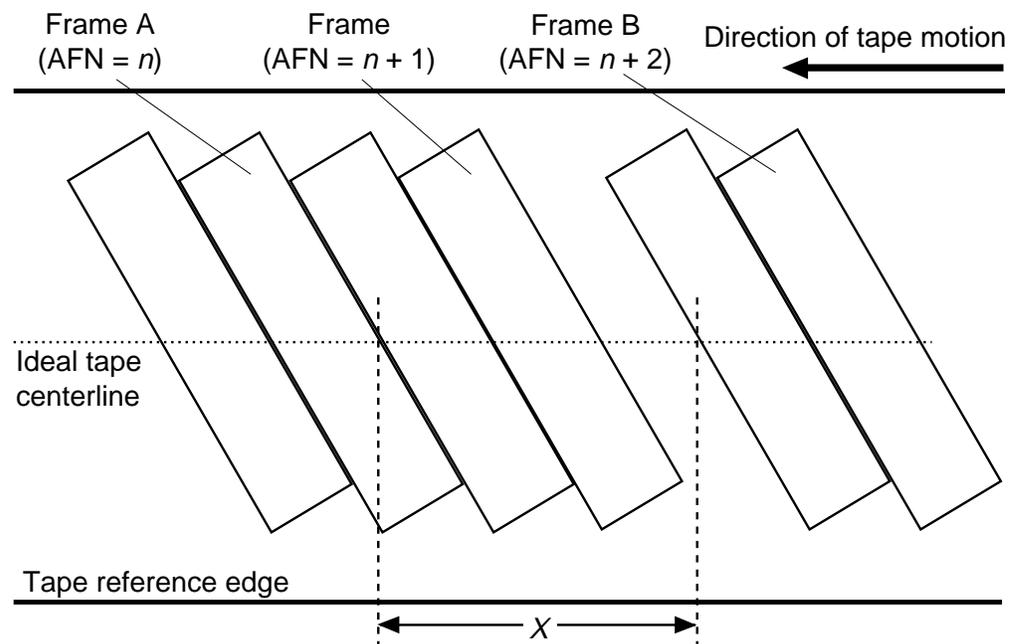


Figure 28. Tolerance on Seamless Appending

The following rules are for the DDS-3 format for a nonseamless append:

1. The distance between Frame A and Frame B should allow for a minimum of one and a maximum of 11 frames. No unrecorded space is allowed between Frame A and Frame B.
2. Discontinuities and repetitions of AFN are permitted between Frame A and Frame B provided that, where Frame A has an AFN of n ,
 - All frames have an AFN greater than n , and
 - Frame B has an AFN of $n + 2$ minimum and $n + 12$ maximum.

3. Amble frames between Frame A and Frame B should have a value of group number that is equal to that of Frame A. Other frames between Frame A and Frame B should have a value of group number that is greater than that of Frame A.
4. There should be a minimum of 29 frames between Frames B and C. For example, if Frame B has an AFN of $n + 2 \leq n' \leq n + 12$, then Frame C should have an AFN of $n' + 30$ minimum. No unrecorded space, physical discontinuity or seam or AFN discontinuity or repetition is allowed between Frames B and C.

EOD Area

The data area is always followed by an *EOD area*. More than one EOD area can exist on tape, but the EOD area closest to LBOT is the only valid one for information interchange. The EOD area is also followed by a *post-EOD area* that extends to the *physical end of tape (PEOT)*.

Early Warning Point (EWP)

The *early warning point (EWP)* functions as an alert from the DDS-3 drive to the host that the PEOT is being approached. Any data transfer operation currently underway should be completed, the data should be recorded to tape and no more data transfers occur until a new cartridge is loaded.

In the case of a new or unwritten tape, the EWP is calculated by the drive based on a number of factors including tape cartridge type (which automatically renders a media length factor) and is then held in memory. By specification, the EWP is always a minimum of 3 mm before the PEOT. If data is recorded beyond the calculated EWP, the after early warning point (AEWP) bit is set on the last basic group completely or partially recorded before that point. The AEWP now denotes the position of the EWP the next time that the tape is read. In addition, this information is also recorded into the system log as part of the update of the tape history before unloading the tape.

For a tape that contains data, but which is being overwritten, the drive follows the same procedure as with a new or unwritten tape. The drive calculates the EWP, ensuring that the calculated EWP is not less than 3 mm before the PEOT. If data is written beyond the EWP, the AEWP bit is set on the last basic group completely or partially recorded before that point. The AEWP now represents the position of the EWP for the next read. The system log is also updated at unload time to reflect this.

Initialization

Initialization refers to the process of preparing the tape for recording user data for the first time. The reference area, system area and the vendor group are all recorded per DDS-3 standard requirements in preparation for recording of the first recorded data group to tape.

Performing the Initialization step on a previously recorded tape effectively destroys all data contained on the tape, including that found in the reference area, system area and in the vendor group.

Layout of a Partitioned Tape

A *partitioned tape* provides the end-user with two independent partitions, or effectively two single data space tapes on one tape cartridge. Each of the two partitions have the similar structure and properties to those of a single data space tape.

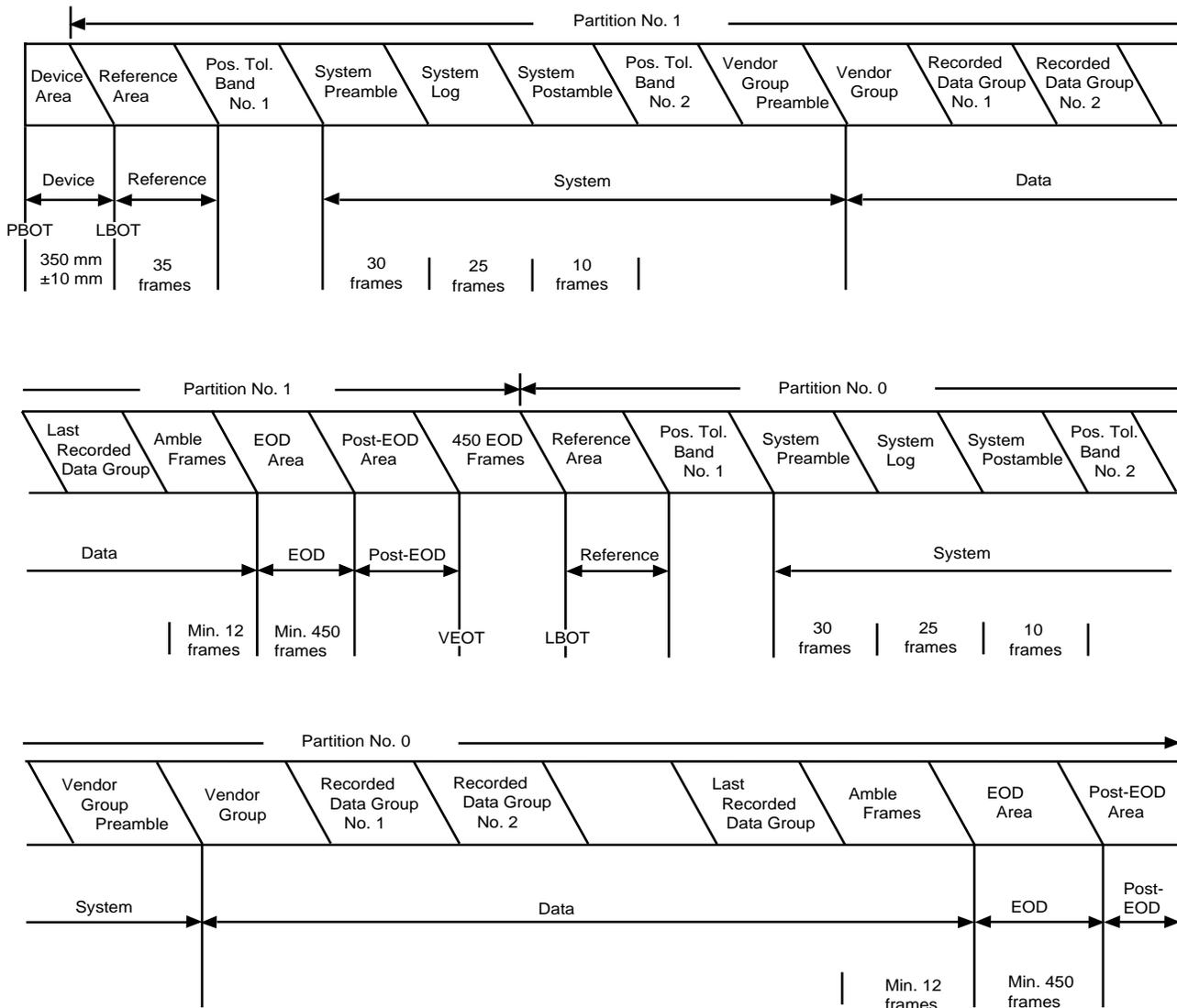


Figure 29. Layout of a Partitioned Tape

Each partitioned tape's layout consists of a device area, *Partition 1* and *Partition 0*, located in order from PBOT to PEOT.

The device area is identical to that of a single data space tape.

Partition 1

The total number of frames in Partition 1 is recorded in the system log of Partition 1.

The *virtual end of tape (VEOT)* is a reference point for Partition 1, the same as the PEOT on a single data space tape. The VEOT is found 450 frames before the partition boundary.

The *Partition 1 early warning point (EWP)* functions the same as the EWP for a single data space tape except that the EWP is not less than 3,067 frames (approximately 500 mm) before the VEOT.

Partition 1's Data Area is followed by the *Partition 1 EOD Area*. The EOD Area can be up to 450 frames in length and consist of tape-management frames, beginning after the last amble in the sequence of amble frames following the last recorded data group.

In the event that the end of the EOD area occurs before the VEOT, it is followed by a *post-EOD area* extending to VEOT.

Partition 0

Immediately following Partition 1's VEOT, and after Partition 1's EOD frames, Partition 0 begins with its LBOT. The LBOT is the partition boundary. The first frame after this point has the absolute frame number (AFN) of 1.

The composition of Partition 0 is virtually the same as Partition 1.

Initialization of Partitioned Tapes

If a new or bulk-erased tape is used as a partitioned tape, we recommend that you perform an initialization pass first. Given the fact that the user data may only fill one partition, leaving the other empty, the initialization process ensures that the partition boundary is correctly set, and Partition 1 and Partition 0 are both set up correctly during the first write pass.

By definition, an *Empty Partition 1* consists of:

- A reference area
- A system area
- A data area, comprising a vendor group and at least 35 amble frames
- A minimum of 3,517 tape-management frames identical to those of the EOD area of Partition 1.

The vendor group preamble, the data area and the subsequent tape-management frames all form a continuum extending to the partition boundary. No unrecorded space, physical discontinuity, seam, absolute frame number discontinuity or absolute frame number repetition is permitted.

An *Empty Partition 0* consists of:

- A reference area
- A system area
- A data area, comprising a vendor group and at least 35 amble frames
- An EOD area 450 frames in length at a minimum.

The vendor group preamble, the data area and the EOD area all form a continuum. No unrecorded space, physical discontinuity, seam, absolute frame number discontinuity or absolute frame number repetition is permitted.

Housekeeping Frames

Housekeeping frames do not include user data. There are three types of housekeeping frames: *amble frames*, *system log frames* and *tape management frames*.

Specific rules govern where and how these frames are recorded. Please refer to the DDS-3 standard for these rules.

DDS-3 Recording Format Standard—Further Reference

For more information about the DDS-3 Recording Format Standard, refer to ECMA-236, *3.81mm Wide Magnetic Tape Cartridge for Information Interchange - Helical Scan - DDS-3 Format using 125m Length Tapes*.

A copy of the standard can be obtained by contacting ECMA at:

Phone: 41-21-849-60-00
FAX: 41-22-849-60-01
URL: <http://www.ecma.ch>
Internet: helpdesk@ecma.ch

Introduction

Data Compression—General

Typical data streams of text, graphics, software code or other forms of data contain repeated information of some sort, whether it is at the text level where you can readily recognize regular repetitions of a single word or at the binary level where the repetitions are in bits or bytes. Although most data is unique and random, the binary level data exhibits patterns of various sizes that repeat with varying degrees of regularity.

Storage efficiency is increased if the redundancies or repetitions in the data are removed before the data is recorded to tape. Data compression technology functions to significantly reduce or eliminate the redundancies in data before recording the information to tape. This increases the amount of data that can be stored on a finite medium and increases the overall storage efficiency of the system.

With data compression, the redundant information in a data stream is identified and then represented by codewords or symbols, which allow the same data to be recorded in a fewer number of bits. These symbols or codewords point back to the original data string, using fewer characters to represent the strings. Because these smaller symbols are substituted for the longer strings of data, more data can be stored in the same physical space.

Some important benefits result from data compression in DAT drives:

- The same amount of information can be stored on a smaller length of tape.
- More data can be stored on a given length of tape.
- Performance can more closely parallel to that of high-transfer-rate computers.
- More information can be transferred in the same time interval.

Data Compression Considerations

In an effective data-compression method, several factors are important:

- The amount of compression (measured by the *compression ratio*, which is a ratio that compares the amount of uncompressed data to the amount of compressed data and is obtained by dividing the size of the uncompressed data by the size of the compressed data)
- The speed with which data is compressed and decompressed in relation to the host transfer rate
- The types of data to be compressed
- The data integrity of the compressed data

The amount of compression possible in a data stream depends on factors such as the data pattern, the compression algorithm, the pattern repetition length, the pattern repetition frequency, the object size (block of information to be compressed) and the starting pattern chosen.

The transfer rate depends on factors such as the compression ratio, the drive buffer size, the host computer input/output (I/O) speed, the effective disc speeds of the host computer and the record lengths that the host computer transmits.

Data compression algorithms can be tailored to provide maximum compression on specific types of data. But because varying types of data are encountered in normal day-to-day operating circumstances, an effective data compression method for a tape drive must serve various data types. Additionally, the data compression method must *adapt* to different data types, automatically providing optimum handling for all types of data.

Considering these factors, Seagate engineers concluded:

The most effective data compression method must compress as much data as possible under the following conditions:

- The transfer rate of the host computer is not impeded.
- Adaptation is made to different types of data.
- Data integrity is maintained.

Hardware Compression

If data compression is used in software on the host computer rather than in the hardware of the drive, you can slow down the transfer rate of the host because it must perform compression computations in addition to its regular computations. Also, any other host that wants to retrieve (decompress) the data must have the same software.

Hardware data compression (HDC) refers to the implementation of the DCLZ algorithm in the SCSI/data compression chip onboard the drive, with the compression processing activity transparent to the host computer and the user.

Seagate's SCSI/data compression chip is designed to provide a complete data compression system using the DCLZ algorithm. This chip provides support circuitry as well as the core DCLZ compression machine.

A more detailed description of the data compression chip is given later in this chapter.

Data Integrity

There are various types of data-compression algorithms, but in this document they are divided into two basic types: *lossless* algorithms, such as DCLZ or ALDC, and *lossy* algorithms, such as those used in some consumer audio products.

Lossy algorithms drop out or lose some portion of repetitious data during the compression process to reduce the actual data bytes that are recorded to tape. The data lost during this process is lost forever and cannot be recovered. In consumer audio, this is not a problem because this method reduces required storage space and still provides better-than-analog recording and playback quality.

As you would expect, lossy algorithms are inappropriate for computer data storage of any type; hence the choice of lossless algorithms for computer data storage use.

Lossless algorithms are designed to compress data using a complex algorithm, ensuring that all data is compressed and recorded to tape and that all data can be decompressed and returned in the identical format as before. No bits are lost, and no data is compromised.

The DDS standards specify the use of the DCLZ algorithm, a lossless algorithm for data compression.

DCLZ Algorithm

DCLZ Algorithm

Within the computer industry, algorithms developed by Abraham Lempel and Jacob Ziv (enhanced later by Terry Welch) are popular, versatile and powerful compression methods. These LZ algorithms are basically of two types—LZ1, a sliding window method, and LZ2/LZW, a hashed directory method.

LZ2 and *LZW* (Lempel-Ziv-Welch) are algorithms based on the *hashed dictionary* method; these algorithms offer an acceptable compromise between speed and compression ratio. This type of algorithm builds a symbol dictionary to represent strings as the data is processed and then looks up matching patterns in the dictionary. By monitoring the compression ratio in this type of algorithm, a new dictionary can be started when the ratio drops, indicating a change in the data type. This type of algorithm is responsive to changing data patterns while maintaining acceptable speed.

Although dependent on the particular implementation, the LZ2/LZW type of algorithm is generally faster than the LZ1 type because the dictionary structure promotes efficient searching.

The DCLZ algorithm used in the Scorpion 24 tape drive is based on the LZ2/LZW algorithm type described earlier in this chapter. This algorithm has been approved by the US ANSI standards group and the European ECMA standards group. Both the DDS Manufacturers Group and QIC tape industry-standards committees accept DCLZ as an approved standard. Within the DDS Manufacturers Group, DCLZ is the only approved standard, ensuring complete interchange across all DDS drives and media.

Simplified Compression Operation

The following steps describe a simplified version of operation of the algorithm for compressing data.

1. From the current position in the input data stream, the algorithm fetches bytes (characters) until a string is formed that does not have a matching entry in the dictionary.
2. The codeword for the longest string that has an entry in the dictionary (all bytes except the last) is output.
3. A dictionary entry for the string formed in step 1 is created.
4. The current position is moved to the last byte of that string.
5. Steps 1 through 4 are repeated until the input data stream is completely processed.

The following table illustrates this simplified operation.

<i>Input Byte</i>	<i>Current String</i>	<i>Match</i>	<i>Build Entry</i>	<i>Output Code Value</i>
R	R	Y	—	—
I	RI	N	RI	(R)
—	I	Y	—	—
N	IN	N	IN	(I)
—	N	Y	—	—
T	NT	N	NT	(N)
—	T	Y	—	—
I	TI	N	TI	(T)
—	I	Y	—	—
N	IN	Y	—	—
T	INT	N	INT	(IN)
—	T	Y	—	—
I	TI	Y	—	—
N	TIN	N	TIN	(TI)
—	N	Y	—	—

Dictionary

The dictionary is built and contained logically in external RAM and is not output as a distinct item. Rather, the decompressor recreates the dictionary to recreate the original data.

The dictionary allows up to 4,096 entries with each entry made up of:

- The unique string found in the data stream
- The codeword for that string

Codewords represent strings of up to 128 characters and are formed by adding a new character to an existing codeword. These codewords range from 9 through 12 bits in size and are assigned a number in the range 0 through 4,095.

These codewords are either control flags, encoded bytes or dictionary codes. The following points explain these three types of codewords.

- **Control Flags, codewords 0 through 7:** These control flags are reserved codewords that flag specific conditions as follows:
 - 0 Dictionary frozen
 - 1 Dictionary reset
 - 2 Increment codeword size
 - 3 End of record (EOR)
 - 4–7 Reserved
- **Encoded bytes, codewords 8 through 263:** These encoded bytes represent single bytes of the input data stream and contain the values 0 through 255.

- **Dictionary codes, codewords 264 through 4,095:** The dictionary codes refer to dictionary entries and represent multiple bytes (a string of characters) in the input data stream. These codes are built as the input stream is processed. These codes are pointers to other locations and eventually end by pointing to one of the byte values 0 through 255. A linked chain is created that builds up a string of characters.

Each dictionary entry is 23 bits long and comprises a logical RAM address. The information is stored in 8-bit-wide static RAM chips that are 8K, 10K, or 16K by 22-bits. The structure of each dictionary entry is as follows:

- **Bits 0 through 7** contain the byte value of the entry.
- **Bits 8 through 19** contain the codeword that represents the entry or that points to a previous entry (encoded byte or dictionary code).
- **Bits 20 through 22** are condition flag bits.

Dictionary codewords range from 9 through 12 bits in length and correspond to dictionary entries from 0 through 4,095. These entries are divided as follows:

- First 512 entries are 9-bit codewords.
- Second 512 entries are 10-bit codewords.
- Next 1,024 entries are 11-bit codewords.
- Final 2,048 entries are 12-bit codewords.

Simplified Decompression Operation

The DCLZ algorithm requires that compression and decompression be tied together through:

- The compression and decompression processes (requires synchronization)
- The packing and unpacking of codewords into a byte stream (requires synchronization)

That is, decompression of the data does not begin at an arbitrary point; rather, it begins at a point where the dictionary is reset—known to be empty. This stipulation is vital because the dictionary is embedded in the codewords, which saves time and space as it is not recorded separately.

Likewise, the packing and unpacking process require synchronization so that the compressed data is presented to the algorithm in the proper order.

The following steps describe a simplified version of the operation of the algorithm for decompressing data.

1. From a reset dictionary point, (which contains only control codes and encoded bytes) codewords are fetched from the input stream and looked up in the dictionary.
2. New dictionary codes are built by combining the previously received codewords. (The dictionary created during compression is recreated, guaranteeing that any codeword received is contained in the dictionary.)

Codewords that are encoded bytes are output directly. Codewords that are dictionary codes lead the algorithm through a series of bytes and codewords that point to other dictionary entries. Bytes are stacked until an encoded byte occurs; then, the stack is output.

The following table illustrates the reverse process of compression, showing simplified decompression operation.

<i>Input Code Value</i>	<i>Byte Value</i>	<i>Pointer</i>	<i>Root?</i>	<i>LIFO</i>	<i>Entry</i>	<i>Output Byte</i>
(R)	R	—	Y	R	—	R
(I)	I	—	Y	I	RI	I
(N)	N	—	Y	N	IN	N
(T)	T	—	Y	T	NT	T
(IN)	N	(I)	N	N	—	—
—	I	—	Y	NI	TI	I
(TI)	I	(T)	N	I	—	—
—	T	—	Y	IT	INT	T
—	—	—	—	—	—	I
(N)	N	—	Y	N	TIN	N

The following table shows the dictionary based on the table above and the table on page 65.

<i>Codeword</i>	<i>Byte Value</i>	<i>Code Value (Pointer)</i>
(RI)	I	(R)
(IN)	N	(I)
(NT)	T	(N)
(TI)	I	(T)
(INT)	T	(IN)
(TIN)	N	(TI)

SCSI/Data-Compression Chip

Overview

The Seagate SCSI/data-compression chip contains compression and decompression circuitry, which forms the core of the data-compression system using the DCLZ algorithm. This core is called the *DCLZ compression machine*.

The DCLZ machine compresses data from the SCSI bus before it is transferred to the local control bus. When compressing information, data originates from the SCSI bus and passes through the SCSI core to the DCLZ machine or data-compression core. However, that interface performs byte operations in the event of an odd block size.

The Seagate SCSI/data-compression chip used in the Scorpion 24 tape drive provides the basis for an effective data-compression system using the DCLZ algorithm. The chip includes a SCSI controller and a data-compression processor arranged in an inline configuration.

Like other component devices used in these state-of-the-art drives, the SCSI/data compression chip uses the low-power CMOS technology. The device is packaged in a 100-pin plastic quad flat pack (PQFP).

Features

The SCSI/data-compression device provides the following features:

- Integrated SCSI controller
- Implements DCLZ data-compression algorithm
- Provides 10.0 Mbyte-per-second maximum throughput for synchronous operation and 7.0 Mbytes per second for asynchronous operation
- Compatible with DDS compression standards
- Provides internal data FIFO
- Supports data pass-through mode to bypass compression
- Provides internal SCSI data FIFO
- Built-in DMA control unit

Figure 30 illustrates the layout of the SCSI/data-compression device.

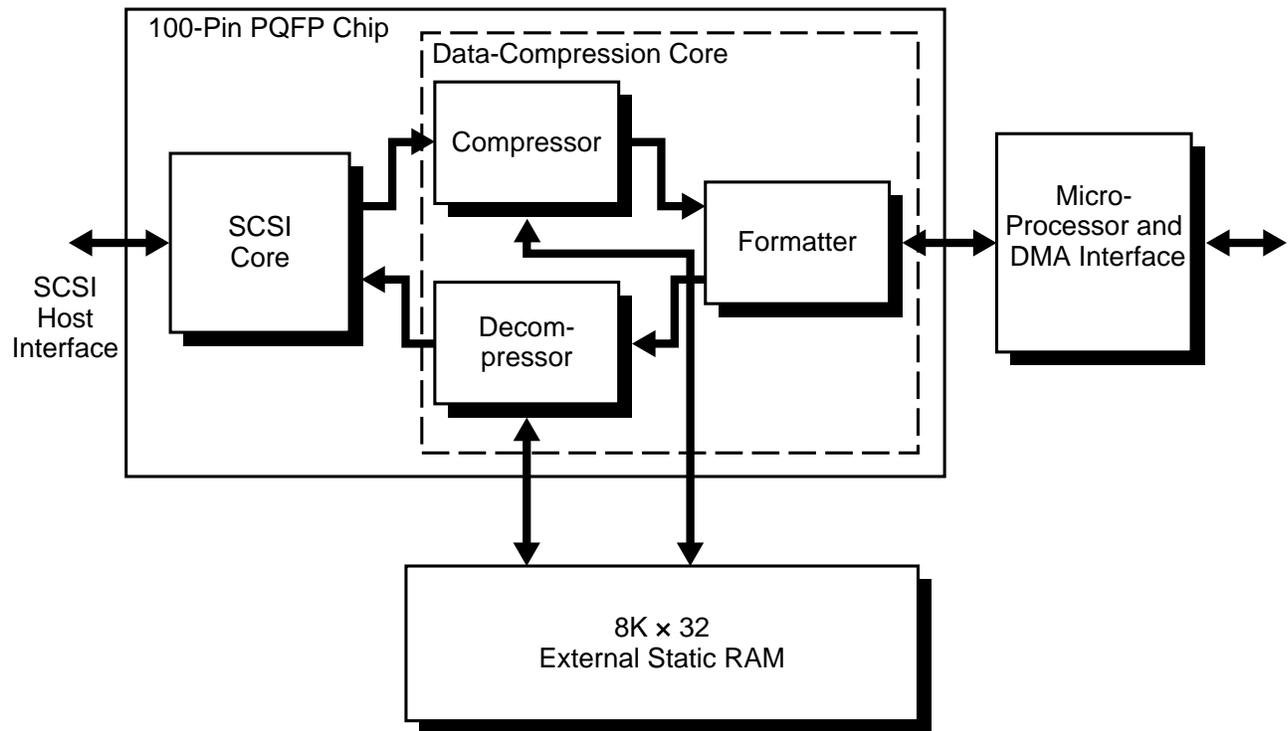


Figure 30. Layout of SCSI/Data Compression Device

Overview

The Scorpion 24 tape drive design integrates DAT technology (helical scan recording method) into a true computer-grade data-storage peripheral with industry-standard data-compression capability.

These drives are the result of:

- Combining the economies of scale from the audio electronics market for key components, such as the cylinder, heads and audio LSIs, with a computer grade drive (3.5-inch) using four direct drive motors, a *no-mode change* mechanism and electronic tape path control for the demanding computer storage environment.
- Implementing a four-head design to provide read-after-write (RAW) error correction and to maximize the benefits of the helical scan recording method, namely: (1) high-density recording (all tape space is used by dense, overlapping tracks at alternating azimuth angles) and (2) high-speed searches.
- Using second-generation audio and custom LSIs for efficient circuit layout and increased reliability with low power consumption. These LSIs are quad-flat-pack (QFP) designs that use complementary metal-oxide semiconductor (CMOS) technology.
- Implementing the DDS-3 format.
- Implementing hardware data compression in the drive using the SCSI/data-compression chip.
- Using flash memory devices for easy firmware upgrades.
- Storing configuration information in the parameter block of flash memory.
- Enabling the user to access configuration information in the flash memory using the SCSI MODE SENSE command and to program the flash memory using the SCSI MODE SELECT command.
- Implementing custom C3 ECC coprocessor capabilities and other error-correction techniques.
- Embedding a full-LSI SCSI controller with capability for SCSI-2 command sets in single-ended SCSI DDS-DC models.

This chapter describes the Scorpion 24 DDS-3 drive in more detail and explains implementation-specific information.

The STD124000N Drive

The Scorpion 24 uses the helical scan recording method with a four-head cylinder design. Four direct-drive motors and one brush-type motor are used in the drive. The read and write functions use LSIs. Engineering decisions—such as the modular partitioning of the electronics and use of surface mount, low power commercial and custom LSIs—allow the drives to conform to the industry-accepted 3.5-inch form-factor. These design features are also important contributors to the overall reliability, durability and performance of the drive.

The Scorpion 24 mechanism is designed for minimum tape wear and prevention of damage to the tape. The modes or operational states, such as stop, rewind and play, reduce mechanism and tape wear. Fewer mechanical mode changes result in less wear on key drive components. In some cases, the need for a mode change is circumvented using the Pause mode, which stops the tape without activating the mechanism. All mode selection is performed by the controller firmware. The host computer does not directly control mode selection.

A custom timing tracking design (described in detail in Chapter 6), combined with the four-head cylinder design, implements the specifics of the DDS-3 recording format standard and provides the precision required to perform seamless appends, or the ability to add subsequent recorded data frames immediately adjacent to the last data frames written on the tape.

A bank of jumpers is available at the rear of the drive. These jumpers allow you to set the SCSI ID for the drive and to change configuration choices. Refer to chapter 3 for information about setting these jumpers.

By using the jumpers, you can also enable terminator power if needed. (The default for internal models is with terminator power disabled. For external drives, the default is with terminator power enabled.)

Note. The Scorpion 24 comes supplied with a terminator power fuse to provide protection from component damage in case the SCSI cable is connected incorrectly.

Two rectangular front-panel light-emitting diodes (LEDs) indicate a drive busy status and tape cartridge in place status. When blinking, these LEDs also function as fault indicators. (Refer to Chapter 4 for a summary of the function of these LEDs.) The external subsystem also provides a round, green LED on the front panel to indicate power on.

Motors and Control Circuits

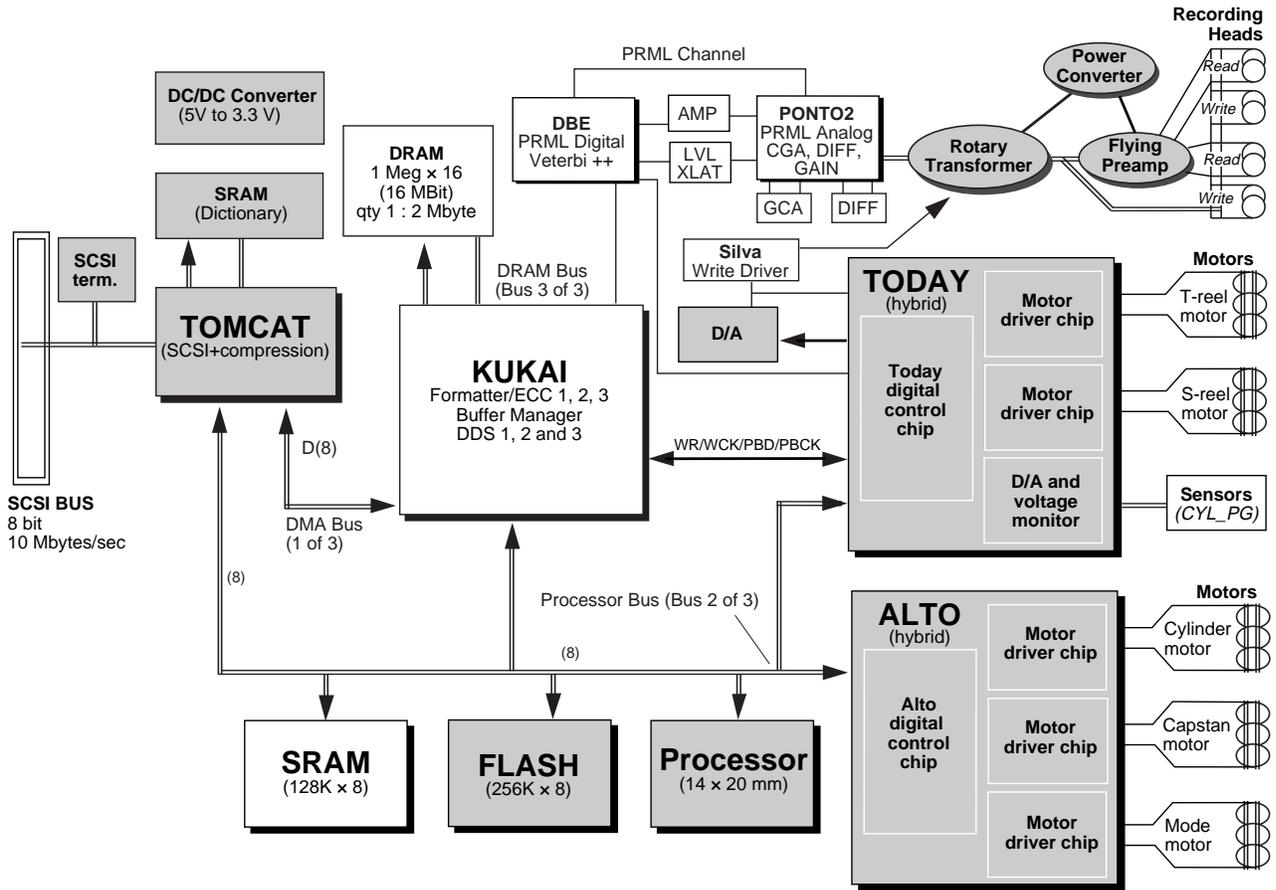


Figure 31. Simplified Block Diagram—Scorpion 24 DDS-3 Drive

SCSI Controller

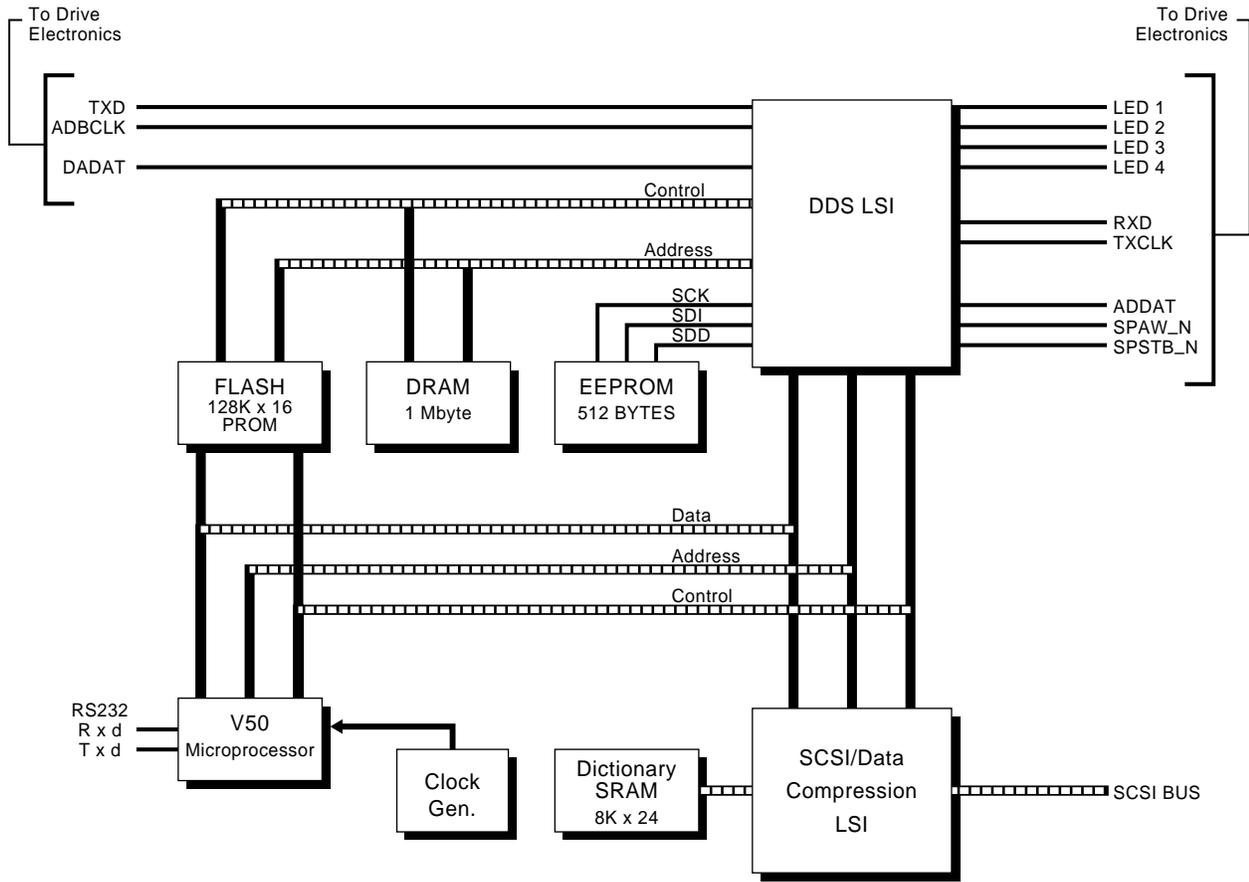


Figure 32. Block Diagram—SCSI Controller DAT Models

Helical Scan Recording—Four-Head Design

In helical scan recording, the heads are positioned opposite one another on a cylinder, which is tilted approximately 6 degrees from the vertical plane and rotates counterclockwise at 4,000 revolutions per minute (rpm). At the same time, the tape moves slowly (0.430 inches per second in DDS-3 mode) in a horizontal path around part of the cylinder. This simultaneous motion of cylinder and tape results in the head traveling across the width of the tape in a helix-shaped motion.

The cylinder is designed with four, long-life ferrite heads—two read and two write heads. These heads are set opposite one another with a rotation sequence of: write A, read B, write B, read A (or write A new, read B old, write B new, read A old). The advantage of this design is that a RAW check is performed immediately after the data is written.

As mentioned earlier, the cylinder rotates rapidly (4,000 RPM) in the same direction that the tape moves. The wrap angle of the tape on the cylinder is approximately 102 degrees. This wrap angle and the slow tape speed minimize tape and head wear. The combined movement of the tape and cylinder results in a relative head-tape speed of 243 inches per second (ips).

Figure 33 illustrates a helix track, the four-head design and shows the 102 degree wrap angle.

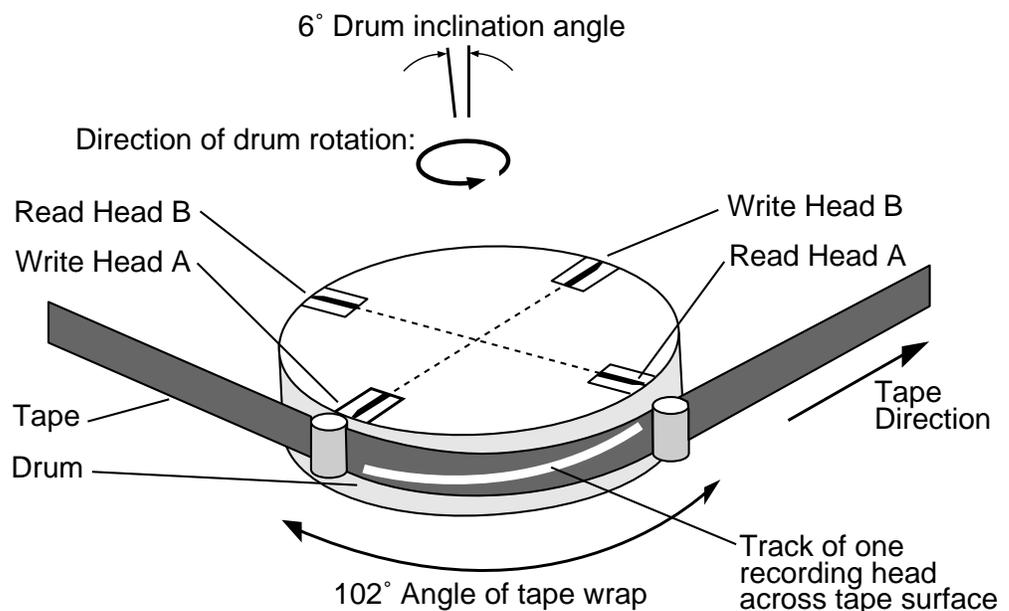


Figure 33. Four-Head Design

The recorded tracks are written diagonally across the tape from bottom to top by each write head. Because the head is wider than the track written, tracks overlap with no tape space between them. In conventional recording, such overlap or even proximity results in crosstalk (signals from adjacent tracks interfering with signals from another track).

However, in helical scan recording, the heads are set at different azimuth angles so that alternate tracks on the tape are written at alternate azimuth angles. (See Figure 34.) Because the read head is set to the same angle as its corresponding write head, it picks up a stronger signal from data written in the same azimuth angle as itself. So it reads the track with minimal crosstalk. At the same time, the head is maintained centered in the track by the timing tracking hardware and firmware.

Figure 34 shows alternate tracks and alternate azimuth angles.

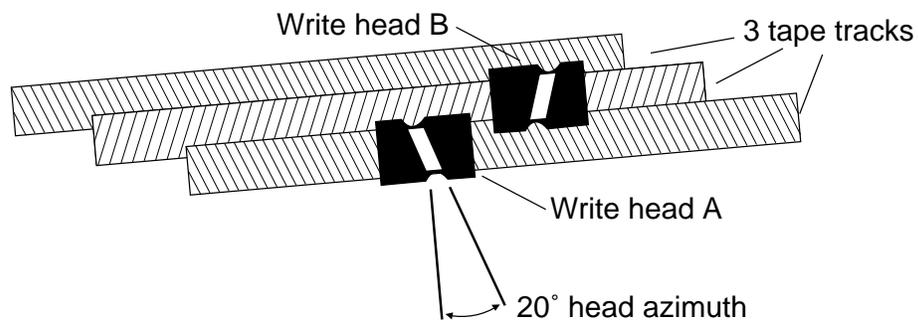


Figure 34. Alternate Azimuth Angles

Motors and Control Circuits

The Scorpion 24 drive uses four direct-drive, brushless motors—the capstan, cylinder and two reel motors. Using these small, direct-drive motors provides maximum reliability. The cylinder motor rotates the cylinder. The capstan motor moves the tape. The mode motor loads and ejects the cartridge. The two reel motors turn the tape reels.

Cylinder, capstan and reel servo is controlled by custom ASICs and the motor control firmware.

The fifth motor in the mechanism is a brush-type mode motor. This motor controls (selects) the mechanism mode. Because the mode motor is not frequently used, the brush-type motor is best suited to this application. The mode motor performs the mode changes as directed; for example, this motor conditions the mechanism to eject the cartridge. The motor is controlled by a driver that receives instructions from mode motor controller.

Read and Write LSI

One high-speed, single-chip signal processor and audio DAT-formatter LSI provides the read and write signals for each drive. The LSI is supported by a static RAM. This chip is controlled by the controller microprocessor.

Timing Tracking Circuitry

The timing tracking circuitry of the drive is designed to provide high precision tracking and head positioning. The timing tracking system, in conjunction with the four-head read-after-write (RAW) design provides for reliable high-density data recording with maximum storage efficiency. For detailed information about timing tracking implementation, refer to Chapter 6 on page 47.

SCSI Controller

The embedded SCSI controller circuitry in the drive is made up of several components. A single chip DDS formatter LSI communicates with the microprocessor and with the read and write LSI. The C3 ECC coprocessing capability and the memory control function are also included in this single chip. Other components vital to this circuitry are the high-performance SCSI core in the SCSI/data-compression LSI chip, the microprocessor and the flash memory. The standard dynamic RAM (DRAM) buffer is 2 Mbytes.

The SCSI/data-compression chip, which is a 100-pin PQFP, provides the SCSI core and the DCLZ machine. The SRAM (compression memory) external to the device is part of the SCSI controller circuitry. Refer to Section 7.3 for a more detailed discussion of the SCSI/data-compression chip.

Flash memory

Because the Scorpion 24 uses flash memory, the drive firmware can be easily upgraded when new revisions of the firmware are released. The SCSI controller circuitry includes 512 Kbytes of flash memory on these models.

You can load new firmware in one of three ways:

- Using a specially encoded firmware upgrade cartridge
- Issuing a SCSI Write Data Buffer command to download the firmware to the EEPROM
- Through the drive serial port

Refer to Chapter 4 on page 33 for information about loading new firmware using a Seagate firmware upgrade cartridge.

Sensors

A number of mechanical and optical sensors are integrated in the drive design. The *cartridge in* and *cartridge loading* sensors are mechanical sensors that determine the position of the loading mechanism. The other mechanical sensors report specific information based on detecting the open or closed state of four recognition holes in the DAT cartridge. The open or closed state of these holes designate tape type, whether the tape is a cleaning cartridge, whether the tape is prerecorded and whether the tape cartridge is write-protected. These mechanical sensors and the sensor for the cartridge in status comply with the DDS-3 standard requirements for the cartridge.

The beginning-of-tape (BOT) sensor is an optical sensor that uses the light path transmissivity of leader tape, as specified in the DDS cartridge standard. The sensor is also designed to recognize media recognition system (MRS) cartridges, which have a series of alternate opaque and clear stripes at the beginning of the tape.

The reel sensors for the two reels are optical. Also, three optical sensors detect mechanism position during mode changes.

The capstan sensor is a magnetoresistive Hall sensor that detects a magnetic field. The cylinder sensors are coil and magnet sensors. Each reel motor contains a high-resolution, optical speed encoder.

Read-After-Write

The read-after-write (RAW) technique provides a means of verifying that host data was written on the tape correctly by applying a read check immediately after writing the data to tape. The read check is a comparison of the actual signal quality versus a predetermined acceptable threshold level.

If a frame is identified as bad, it is rewritten later down the tape. The bad frame is not necessarily rewritten immediately. It can be rewritten after three, four or five other frames have been written. Any frame can be rewritten multiple times to provide for skipping over bad areas on the tape.

Excessive consecutive rewrites typically signal a degraded media condition; in these cases it is best to discontinue use of the tape in question and continue with a piece of good media.

During a read or restore operation, the threshold level is reduced to maximize the likelihood that data can be successfully retrieved from tape. The combination of the elevated read threshold during write and reduced threshold during read ensures that data is written with the highest possible margin and that recorded data can be read or retrieved with the highest possible confidence.

Media Recognition System (MRS)

The Scorpion 24 tape drive includes support for the media recognition system (MRS), which is unique to DDS products.

The MRS refers to a series of alternate opaque and clear stripes at the beginning of each tape. These stripes are used to classify the media as data or computer grade, rather than audio grade media.

Internal to the drive is a system of optical sensors and electronics to identify the MRS stripes to determine whether the tape is computer-grade media. The MRS capability can be enabled or disabled using the drive's dip switch. When enabled, the drive does not allow any write operations to any non-MRS tape cartridges.

All DDS-3 (125 meter), DDS-2 (120 meter) and DDS (90 meter) tape cartridges have MRS striping to signal that they are computer grade media. DDS (60 meter) cartridges may or may not have the MRS striping.

All DDS tape cartridges with the MRS striping either have the MRS logo, the MRS acronym or *media recognition system* printed on them to readily distinguish them from audio-grade media.

Audio-grade media is not suitable for data or computer backup purposes. It is not recommended for use in the Scorpion 24 tape drive.

DDS Data Cartridge

The Scorpion 24 tape drive is designed to use data-grade DDS cartridges, which comply with the specifications in the *3.81-mm Helical-Scan Digital Computer Tape Cartridge for Information Interchange, ANSI X3B5/89-156* standard. Seagate recommends Seagate-qualified, data-grade DDS DAT cartridges (Model M31300, 60 meters; Model M32000, 90 meters; and Model 34000, 120 meters, Model 324000, 125 meters) to ensure optimal data integrity and reliability.

Seagate also recommends the use of a Seagate-qualified DDS head-cleaning cartridge (Model M7301).

Note. Proper maintenance of the drive requires that you use the DDS head-cleaning cartridge after every 25 hours of read/write operation and whenever the rectangular, green cartridge-in-place LED flashes during operation.

Chapter 9 discusses the DDS head-cleaning cartridge in detail.

You can order both DDS data and head-cleaning cartridges from Seagate. They are packaged in multiples of five.

These small (approximately 2 inches × 3 inches × 0.4 inch) cartridges house magnetic tape that is 3.81 mm (0.150 inch) wide. The DDS cartridges are slightly bigger than a credit card. Figure 35 shows the DDS cartridge.



Figure 35. DDS Cartridge

Qualified DDS cartridges are designed with specific file protect, lid and other features for information interchange and are tested to comply with the ANSI DDS specifications.

The Scorpion 24 drive also recognizes all MRS cartridges when MRS is enabled. MRS cartridges have a series of alternate opaque and clear stripes at the beginning of the tape. These stripes classify the media as data grade, rather than audio-grade media. Figure 36 points out the four recognition holes that allow the drive sensors to identify the type of tape, its magnetic thickness and whether the tape is prerecorded, unrecorded or is a cleaning cartridge. Other cartridge features allow the drive to optically sense cartridge in, BOT and EOT.

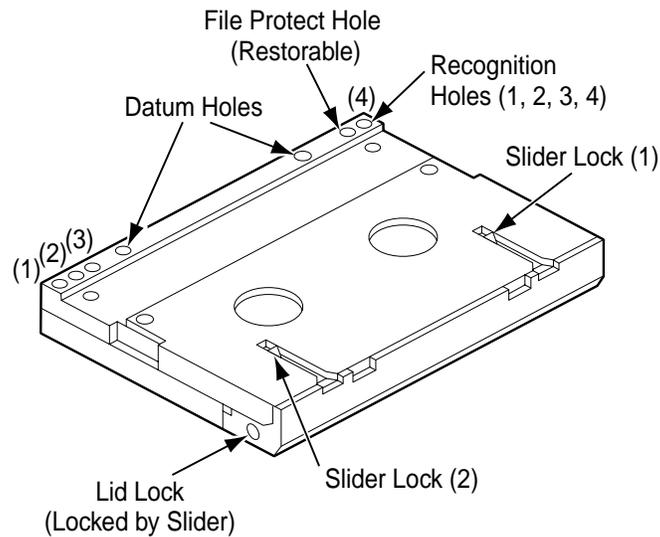


Figure 36. Cartridge Design Features

The cartridge also provides for write protection so that existing data on the cartridge is not overwritten. A write-protected cartridge allows the existing data to be read but does not allow new data to be written to the tape.

Note. A write-protected cartridge prevents the error log (in the system area) from being updated.

Figure 37 shows the sliding write-protect tab on the DDS cartridge and its positions for write protect and write permit. When the tab is pushed into the closed position, it allows writing to the cartridge tape.

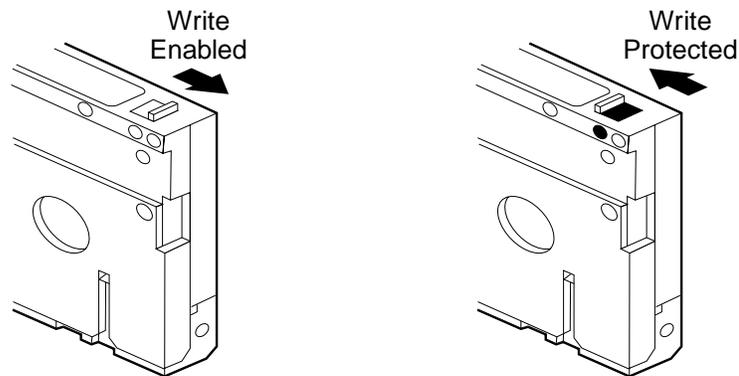


Figure 37. Write-Protect Tab on the DDS Cartridge

Maintenance

If excessive dust or debris collects at one or more of the heads, magnetic media may become unreadable or unwritable. This situation may occur infrequently, or not at all, depending on the media used.

Head Cleaning

Whenever the green cartridge-in-place status LED flashes, you should clean the drive heads with a cleaning cartridge.

Also, as routine maintenance, you should clean the drive heads after the first four hours of tape movement of a new cartridge and after every 25 hours of read/write operation.

Note. The slowly flashing green LED may indicate that a tape is damaged or is nearing the end of its life. If cleaning the head does not correct the flashing LED condition, replace the cartridge. The slowly flashing LED does not indicate a loss of data nor does it affect SCSI operation. (A slowly flashing green LED in conjunction with the yellow LED indicates the presence of a prerecorded audio tape.) For a description of LED operation, see Chapter 4.

To clean the drive heads, use only a Seagate-qualified DDS cleaning cartridge designed for DDS drives. Seagate offers a cleaning cartridge, Model M91301, that you can order.

The DDS cleaning cartridge contains the correct recognition holes to allow the drive to recognize that it is a cleaning cartridge. Follow these general guidelines to use the cleaning cartridge:

- Insert the cleaning cartridge. The drive loads and runs the cartridge for about 30 seconds, then ejects the cartridge.

Note. Each time the cleaning cartridge is loaded, a new, unused portion of cleaning tape is advanced over the entire tape path. Eventually, the entire tape is used, and a new cleaning cartridge is required. (A cleaning cartridge provides approximately 30 uses.) The drive does not rewind the cartridge. If the cleaning cartridge has been used, the drive ejects the cartridge and the amber LED flashes rapidly.

Automatic Drive Spin-Down and Write

To maximize tape and drive mechanism life, the drive automatically stops the cylinder when no tape *read* or *write* activity occurs.

If a read or write operation occurs, normal operation resumes with no affect on the host operation.

If tape Write operations cease, a partially full data buffer may remain. After one minute with no activity, the drive automatically writes the partial buffer to the tape. This automatic action minimizes the possibility of lost data if the power fails.

If data to be written remains in the buffer when the eject button is pushed, the data is written to tape before the tape is rewound and ejected.

Guidelines for High Temperature or Humidity Conditions (Outside the Specified Operating Environment)

Following the guidelines listed below can minimize the possibility of extreme temperature or humidity conditions, causing problems with the drive.

- Use DDS cartridges only at temperatures between 5°C (40°F) and 40°C (113°F). The cartridges can be stored at temperatures down to –40°C (–40°F). Although the storage specifications range from 5°C to –40°C, do not leave cartridges in severe temperature conditions—such as in a car in bright sunlight. Avoid extreme changes in temperature or humidity whenever possible.
- If cartridges are exposed to temperatures or humidities outside the specified operating environment, condition the cartridges by exposure to the operating environment for a time at least equal to the period the cartridges were exposed to the out-of-spec environment (to a maximum of 24 hours).
- Place the drive in a position that provides stable temperatures. Do not place the drive near open windows, fans, heaters or doors.
- Do not read from or write to cartridges when a temperature change of 10°C per hour is occurring.

Reliability

The Scorpion 24 drive is designed for maximum reliability and data integrity. The following table summarizes the reliability specifications.

Feature	Specification
Nonrecoverable error rate	< 1 in 10 ¹⁵ bits
Error recovery and control	Error-correction code techniques (C1, C2, & C3 ECC) Read-after-write (RAW) N-Group writing Error monitoring and reporting (error log) Media specification Retry on read Data randomizer Track checksum
Mean time between failures (MTBF)	200,000 hours @ 20% duty cycle
Mean time to repair (MTTR)	Less than 0.5 hour

Mean Time Between Failures

The mean time between failures (MTBF) is specified at 200,000 hours minimum. This specification includes all power-on and operational time but excludes maintenance periods. Operational time is assumed to be 20 percent of the power-on time. Operational time is the time the tape is loaded on the cylinder (tape moving or cylinder rotating).

Note. The MTBF rating does not represent any particular drive, but is derived from a large database of test samples. Actual rates may vary from unit to unit.

Mean Time to Repair

The mean time to repair (MTTR) is the average time required by a qualified service technician to diagnose a defective drive and to install a replacement drive. The MTTR for DAT products is less than 0.5 hour (30 minutes).

The Seagate DDS drives are field-replaceable units. If a problem occurs with a subassembly or component in the drive, you should replace the entire unit. Return the drive to the factory in its original packaging. Contact your distributor, dealer, your computer system company or your Seagate sales representative to arrange the return.

Acronyms and Abbreviations

<i>Acronym</i>	<i>Meaning</i>
4DD	4 direct drive
ANSI	American National Standards Institute
ATF	automatic track finding
BAT	block access table
BIOS	basic input output system
BOM	beginning of media
BOT	beginning of tape
BPI	bits per inch
CD	compact disc
CMOS	complementary metal-oxide semiconductor
CSA	Canadian Standard Association
DAT	digital audio tape
DCLZ	Data Compression Lempel-Ziv
DDS	digital data storage
DDS-DC	digital data storage data compression
DDS-2	digital data storage-2
DMA	direct memory access
ECC	error-correction code
ECMA	European Computer Manufacturers Association
EEPROM	electronically erasable, programmable read-only memory
EOD	end of data
EOM	end of media
EOT	end of tape
FCC	Federal Communications Commission
FTPI	flux transitions per inch
GIT	group information table
IEC	International Electrotechnical Commission
IPS	inches per second
LED	light emitting diode
LSI	large scale integration
LZ1	Lempel-Ziv 1 (algorithm)
LZ2	Lempel-Ziv 2 (algorithm)
LZW	Lempel-Ziv-Welch (algorithm)
MFM	modified frequency modulation
MTBF	mean time between failures
MTTR	mean time to repair

Acronym	Meaning
OEM	original equipment manufacturer
PCB	printed circuit board
PQFP	plastic quad flat pack
QFP	quad flat pack
QIC	quarter-inch cartridge drive standards, incorporated
RAM	random access memory
RAW	read-after-write
SCSI	small computer system interface
TTL	transistor-transistor logic
UL	Underwriters' Laboratories, Inc.
VAC	volts alternating current
VCR	video cassette recorder
VDC	volts direct current
VDE	Verband Deutscher Electrotechniker
VTR	video tape recorder

Measurements

Measure	Meaning
A	amp
C	Celsius or Centigrade
cm	centimeter
dBa	decibels, A-weighted sound power reference one picowatt
F	Fahrenheit
ft	foot or feet
G	acceleration of a free-falling body; equal to 32.17 feet per second ²
Gbyte	gigabyte
Hz	Hertz
in	inch
k	kilo
Kbyte	kilobyte
kg	kilogram
KHz	kilohertz
lb	pound or pounds
m	meter
M	mega
Mbit	megabit
Mbyte	megabyte
MHz	megaHertz
min	minute
mm	millimeter
msec	millisecond
RPM	revolutions per minute
V	volt
W	watt

Overview

The DAT drives provide a configuration flash memory that contains configuration settings, the drive serial number and other data. You can reprogram some of the configuration parameters in the flash memory using the SCSI MODE SELECT command—MODE SELECT Flash Memory Configuration Page (30_H). You can use the MODE SENSE command—MODE SENSE Flash Memory Configuration Page (30_H)—to return the values that currently reflect the drive configuration information.

When the drive is manufactured, the Configuration flash memory is initially programmed with several factory-default settings. You can issue a MODE SELECT command with page 30_H to program some portions of the flash memory to contain certain options. The parameters are transferred to the drive as data formatted in a parameter list.

Once the flash memory is programmed, the new parameters are in effect after a power-on or SCSI reset conditions. These parameters remain valid until you program the flash memory again with new parameters.

Where applicable, the MODE SELECT command immediately checks for invalid parameters and if an exception is found, the drive returns a Check Condition with the sense data set to Illegal Request.

Complementary to the MODE SELECT command, the MODE SENSE Page (30_H) command allows you to determine the flash-memory parameters. These parameters are sent from the drive to the host as data formatted in a parameter list.

Note. For detailed information about the SCSI interface, including a complete command summary, refer to the *DAT Tape Drives and Autoloaders SCSI Manual* (part number 10002663-00x).

MODE SELECT Flash Memory Configuration Page (30_H)

You use the MODE SELECT Flash Memory Configuration page to program the configuration of the drive. The new settings do not take effect until a power-on or a SCSI reset condition occurs. The settings are valid until the flash memory is programmed again.

A drive with HW=1 (that is, that uses DIP switch settings) does not use most of the settings shown unless reprogrammed to the “use flash memory” setting. A drive needs to be programmed in another parameter (HW field) to use the flash memory configuration over the DIP switches, if it has been set previously to use DIP switches.

The following table shows the layout of the fields of the Flash Memory Configuration Page.

Bytes	Bits							
	7	6	5	4	3	2	1	0
0	0	0	Page code (30 _H)					
1	Page length (02)							
2	Configuration Byte 1							
3	Configuration Byte 2							

The following table shows the fields for the MODE SELECT Flash Memory Configuration Page.

Field Name	Bytes	Bits	Description
Page Code	0	—	The Page Code must be set to 30 _H to select this page.
Page Length	1	—	The Page Length must be set to 2, which shows that 2 parameter bytes follow the Page Length byte.
Configuration Byte 1	2	7–1	Reserved
	2	0	Bus usage optimization as follows: 0: optimize for single drive performance (Default) 1: optimize for best SCSI bus performance with multiple drives on the bus.
Configuration Byte 2	3	7	0: Self-test OFF (Default) 1: Self-test ON
	3	6	Reserved
	3	5	0: Data compression ON (Default) 1: Data compression OFF
	3	4	0: SCSI parity checking OFF (Default) 1: SCSI parity checking ON
	3	3	0: MRS tape checking ON 1: MRS tape checking OFF (Default)
	3	2–0	Reserved

MODE SENSE Flash Memory Configuration Page (30_H)

You use the MODE SENSE Flash Memory Configuration page to determine the user information currently configured for the drive.

A drive with HW=1 (that is, that uses DIP switch settings) does not use most of the settings shown unless reprogrammed to the “use flash memory” setting. A drive needs to be programmed in another parameter (HW field) to use the flash memory configuration over the DIP switches, if it has been set previously to use DIP switches.

The following table shows the layout of the fields of the MODE SENSE Flash Memory Configuration Page.

Bytes	Bits							
	7	6	5	4	3	2	1	0
0	0	0	Page Code (30 _H)					
1	Page Length (0B)							
2	Configuration Byte 1							
3	Configuration Byte 2							

The following table shows the fields for the MODE SENSE Flash Memory Configuration Page.

Field Name	Bytes	Bits	Description
Page Code	0	—	The Page Code must be set to 30 _H to select this page.
Page Length	1	—	The Page Length indicates the number of parameter bytes to follow the Page Length byte.
Configuration Byte 1	2	7–1	Reserved
	2	0	Multiple drives/bus usage optimization as follows: 0: optimize for single-drive performance (Default) 1: optimize for best SCSI bus performance with multiple drives on the bus.
Configuration Byte 2	3	7	0: Self-test OFF (Default) 1: Self-test ON
	3	6	Reserved
	3	5	0: Data compression ON (Default) 1: Data compression OFF
	3	4	0: SCSI parity checking OFF (Default) 1: SCSI parity checking ON
	3	3	0: MRS tape checking ON 1: MRS tape checking OFF (Default)
	3	2–0	Reserved

Glossary

absolute frame number (AFN). A sequence number encoded in the frame.

access point. Beginning of a sequence of compressed records at which point codewords to a decompression algorithm must start—whether or not the required data is at the beginning of the sequence.

algorithm. A set of rules for transforming the logical representation of data.

area ID. An identifier defining the area of the tape and specifying the types of frame written.

azimuth. The angular deviation, in minutes of arc, of the mean flux transition line from the line normal to the tape reference edge.

backup. Copy of a file or collection of files on fixed disc, diskette or tape. Ensures against data loss.

beginning of media (BOM). Equal to the physical beginning of the tape, where the leader tape is joined to the magnetic tape.

beginning of tape (BOT). Equal to the logical beginning of the tape.

bezel. Front panel of a drive.

bit. A single digit in the binary numbering system.

bit error rate. The number of errors divided by the total number of bits written or read.

byte. A group of 8 binary bits operated on as a unit.

cartridge. An enclosure that contains magnetic tape wound on two coplanar hubs and driven by an external drive.

channel bit. A bit after 8–10 transformation.

codeword. A word that is generated by a processing algorithm. The number of bits in a codeword is variable.

compression ratio. The ratio that compares the amount of uncompressed data to the amount of compressed data. It is obtained by dividing the size of the uncompressed data by the size of the compressed data.

crosstalk. Signals from adjacent tracks that interfere with signals from another track.

cutout. The cut-away or step-down portion of the autoloader case that provides access to switches, jumpers and connectors.

data area. The third section of a tape on a DAT cartridge, which is written as a series of groups beginning with the special vendor group.

data compression. The process of removing redundant data from a data stream before recording the data to tape. Compressed data requires less storage space than uncompressed data.

data density. The number of single-byte characters stored per unit length of track. Usually expressed as bits-per-inch (bpi).

data format ID. An identifier that specifies which data format is used on the tape.

decompression. The process of restoring compressed data to its original state.

dictionary. The collection of representations (numeric values) of unique character strings encountered when compressing data.

direct-access operation. Operation of the autoloader in which SCSI commands issued by the host computer select the cartridge, retrieve the cartridge from the magazine and load/unload the cartridge from the drive.

disc drive. A peripheral storage device that rotates the disc, writes data onto it and reads data from it as instructed by a program.

early warning point (EWP). A point along the length of the tape where a warning is given of the approach, in the forward direction of tape motion, of the partition boundary or of the physical end of tape.

end-of-data (EOD). Indicates the point where the host stopped writing data to the tape.

end-of-media (EOM). Equal to the physical end of tape where the trailer tape is joined to the magnetic tape.

end-of-tape (EOT). Equal to the logical end of the tape.

entity. A recorded object that consists of an entity header followed by one or more compressed records.

error-correction code (ECC). Information written on tape during the recording operation that can later be used to reconstruct errors during the data reading operation.

file. A logical unit of information.

fixed disc. A nonremovable hard disc. All data must be transferred to and from the disc through the computer.

fragment. A collection of bytes that are treated as a unit for recording, readback and error correction purposes.

frame. Two adjacent tracks, one A channel (positive azimuth) and one B channel (negative azimuth).

full-height. Usually refers to a tape drive that fits into a vertical space of 3.5 inches.

group. A fixed-capacity set of frames written to or read from the tape. For the DDS and DDS-DC formats, 22 frames comprise a group.

half-height. Refers to the size of a tape drive that occupies a vertical space of about 1.5 inches.

head clog. Particles from the tape or from outside the drive adhere to the head gap on a read or write head and obstruct the reading or writing of data.

helical scan recording. A method of magnetically recording a tape in which the tape wraps around a rotating cylinder with 2 or 4 read/write heads writing at different azimuth angles across the width of the tape in a helix-shaped track.

housekeeping frame. A frame that contains no user data and which is identified as such by the values in the data fields therein.

interleaving. The process of shuffling the order of data bytes before writing them to tape so the consecutive bytes are recorded as far away from each other as possible.

logical beginning of tape. The point along the length of the tape where a recording of data for interchange begins.

magazine. The specially designed, multiple cartridge container that mounts in the magazine holder of the autoloader.

magnetic tape. A tape that accepts and retains magnetic signals intended for input, output and storage of data for information processing.

N-group writing. Sometimes called multiple group writing. This technique repeats each group of data so that there are N consecutive copies of each group on the tape.

noise. A disturbance of the signal caused by the read channel, write channel, head/tape interaction, or conducted or radiated sources.

partition boundary. The point along the length of a magnetic tape at which partition 1 ends and partition 0 begins.

physical beginning of tape (PBOT). The point where the leader tape is joined to the magnetic tape.

physical end of tape (PEOT). The point where the trailer tape is joined to the magnetic tape.

processing. The use of an algorithm to transform host data into codewords.

processed data. A sequence of codewords that results from the application of processing to data.

processed record. A sequence of codewords that results from the application of processing to an unprocessed record.

processed record sequence. A sequence of one or more processed records that starts on an 8-bit boundary and ends on a subsequent 8-bit boundary.

randomizing. A recoding of data symbols before they are written to tape to provide a consistently uniform RF envelope level.

read-after-write (RAW). Reading data immediately after it is written and writing the frame again if an error is found.

record. Related data treated as a unit of information.

reference and system area. The second section of the tape on a DAT cartridge, which provides logs of usage and soft error occurrences.

reprocessing. The use of an algorithm to transform codewords into data as required by the host.

separator mark. A record containing no user data, which is used to separate data.

tape drive. A peripheral storage device that records data onto removable tape cartridges. Used to back up a disc drive. (See also disc drive.)

tape reference edge. The bottom edge of the tape when viewing the recording side of the tape, with the PEOT to the observer's right.

timing tracking. A method of ensuring that the head is in the center of the track that is read.

track. A storage channel on recording tape. For DAT, specifically a diagonally positioned area on the tape on which a series of magnetic transitions is recorded.

uncorrected bit error rate. The probability of a bit that is in error, without using any error-correction techniques.

unprocessed data. Data that has not been subjected to processing.

unprocessed record. A record of unprocessed data, comprising an integral number of bytes.

virtual end of tape (VEOT). The point along the length of the magnetic tape, within Partition 1, that defines the end of the part of Partition 1 that is used for recording data for interchange.



Seagate Technology, Inc.
920 Disc Drive, Scotts Valley, California 95066, USA

Publication Number: 10004436-002, Rev. B, Printed in USA