Seagate Technology

2000, 4000, and 8000 Series
DAT Drives
Product Description Manual

February 1997

Part Number 10003475–001

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 and television reception. It has been type 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.

Document Number 10003475–001

Important Information About This Manual

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Introduction 1

Overview

The Seagate 2000, 4000, and 8000 Series Digital Audio Tape (DAT) drives are designed for computer environments requiring high performance, high capacity data storage. Based on a 3.5-inch mechanism, these internal and external drives provide a native transfer rate of 550 kilobytes/second (KB/sec).

This manual provides information about the drives listed in the following table.

Parameter	DDS	DDS-DC	DDS-2
Capacity	2.0 GB	2.0/4.0 GB*	4.0/8.0 GB*
3.5-in internal	STD12000N	STD14000N	STD18000N
5.25-in internal	STD22000N	STD24000N	STD28000N
External	STD62000N	STD64000N	STD68000N

*Typical with data compression

In this manual references to the drives are generic unless a specific series or model is cited. For most purposes, the information about the drives is the same. The primary differences between the series of DAT drives is the formats supported by the drives. The 2000 series drives support the DDS format; the 4000 series drives support the DDS and DDS-DC formats; and the 8000 series drives support the DDS, DDS-DC, and DDS-2 formats.

All of the drives provide an embedded, single-ended Small Computer Systems Interface (SCSI) controller. The drives are equipped with a 1 megabyte (MB) on-drive buffer to facilitate efficient operation. In addition, the drives offer electronically erasable, programmable, flash memory, which enables qualified Seagate OEMs to download revised firmware to the drive via three methods: using the drive's serial port, the SCSI bus, or a specialized firmware cartridge.

All of the drives comply with the American National Standards Institute (ANSI) and European Computer Manufacturers Association (ECMA) DDS format, which ensures interchange compatibility of digital data stored on a small removable DAT cartridge (approximately 2 inches x 3 inches x 0.4 inch) using 4 mm tape. The 4000 and 8000 seriess drives also comply with the ANSI/ECMA Digital Data Storage Data Compression (DDS-DC) format, which is the industry standard format for DAT data compression and is a superset of the DDS format. These drives use an advanced DCLZ (data compression LempelZiv) algorithm to compress data by up to two or more times. Importantly, DDS-DC data compression is transparent to the host software and SCSI driver.

The 8000 series drives also comply with the ANSI/ECMA Digital Data Storage-2 (DDS-2) format, which provides for writing data in helical tracks that are narrower than standard DDS track width, allowing 50 percent more tracks on a tape. This high-density recording format requires a high output metal particle tape called MP+, which is specifically designed for narrow-track recording. With data compression, the drives can typically store 8.0 gigabytes (GB) of data on an extended-length 120-meter MP+ tape at the typical transfer rate of 1100 KB/sec.

The 4000 and 8000 drives can read and write both compressed and noncompressed data in both the DDS and DDS-2 (8000 only) formats. The tape format recorded by the drive is determined by the type of cartridge installed. If a DDS-2 cartridge is installed as determined by the recognition holes, the drive records in the DDS-2 format. Otherwise, the drive records in the DDS format. The drive reads in the format recorded on the tape.

Because the DDS-DC format is a superset of the DDS format, the drives are fully compatible with the DDS format for reading and writing standard, uncompressed data. To switch operation from compressed to uncompressed mode, the host computer can issue a SCSI command.

For the 4000 and 8000 series drives, tape capacity and sustained data transfer rate using data compression are dependent upon the characteristics of the files being compressed, along with other parameters, including the speed of the host system, and the operating system and application software used. However, Seagate 4000 and 8000 series drives typically provide a doubling of storage capacity and transfer rate—and a maximum quadrupling of storage capacity and transfer rate—when compared with their native noncompressed operation. The typical drive sustained transfer rate using data compression is 1100 kilobytes/second (KB/sec). For a 60-meter DDS data cartridge, the drive using the DDS-DC format provides a typical 2.6 GB; on a 90-meter DDS cartridge, it provides a 4.0 GB storage capacity.

These drives combine inherent DAT technology, DDS-DC data compression capabilities (4000 and 8000 series), and high density (DDS-2) recording (8000 series) with Seagate's proven computer grade design to provide unmatched reliability and performance characteristics among DDS products. These drives are ideal for workstations, networks, and enterprise applications such as:

- Backup of high capacity fixed disks.

- Data interchange between systems.

- Network server

- Loader products.

- Online data collection.

- Direct-access secondary storage for text, graphics or multimedia information of all types.

- Archival storage.

All DAT drives contain an embedded SCSI controller that supports SCSI-2 (*ANSI X3.131, 199x*). The 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. The drives also provide synchronous or asynchronous SCSI and a high speed burst rate of 10 MB/second.

These products provide unmatched reliability through three levels of error correction code (ECC) and the four-head design, which allows read-after-write (RAW) error detection and correction. The internal data compression models also contain an onboard serial port that provides the capability for extensive testing of the drives.

All drives comply with the DDS tape format standard, *ANSI Helical-Scan Digital Computer Tape Cartridge 3.81 mm (0.150 in) for Information Interchange*. The 4000 and 8000 series drives comply with the DDS-DC tape format standard, *ANSI Helical-Scan Digital Computer Tape Cartridge 3.81 mm (0.150 in) for Information Interchange*, *Extended Digital Data Storage Format*. The 8000 series drives also comply with the *ANSI/ECMA Helical Scan Recording - DDS-2 Format Using 120M Length Tapes* standard.

These drives are designed to use data-grade DDS DAT media, not audio DAT media, and provide maximum data integrity and reliability with computer DAT cartridges officially qualified by Seagate. The Seagate-qualified Model M31300 DDS data cartridge (60 m), Model M32000 DDS data cartridge (90 m), and M91301 DDS head-cleaning cartridge are recommended. For reading and writing the DDS-2 format (8000 series), Seagate-qualified 120 m cartridges—Model M34000—are recommended.

Models

The DAT SCSI drives described in this manual are as follows:

- 3.5-inch, half-high DAT drives that mount internally (Models STD12000N, STD14000N, and STD18000N).

- 5.25-inch, half-high DAT drives that consist of a 3.5-inch drive with 5.25-inch mounting rails and bezel that mounts internally in a 5.25-inch half-high space (Models STD22000N, STD24000N, and STD28000N).

- Complete external subsystem containing the 3.5-inch DDS-2 DAT drive and built-in worldwide power supply (Models STD62000N, STD64000N, and STD68000N).

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

Figure 1-1
3.5-Inch Internal DAT Drive
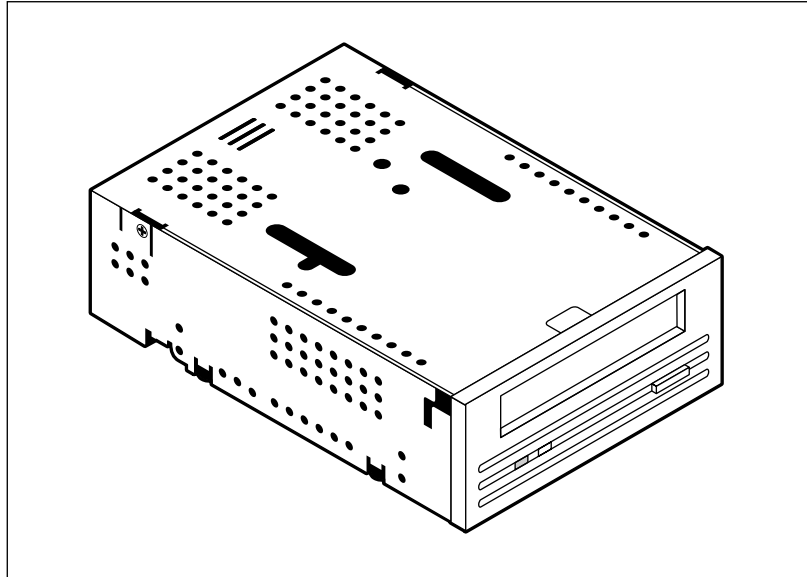
Figure 1-2
5.25-Inch Internal DAT Drive
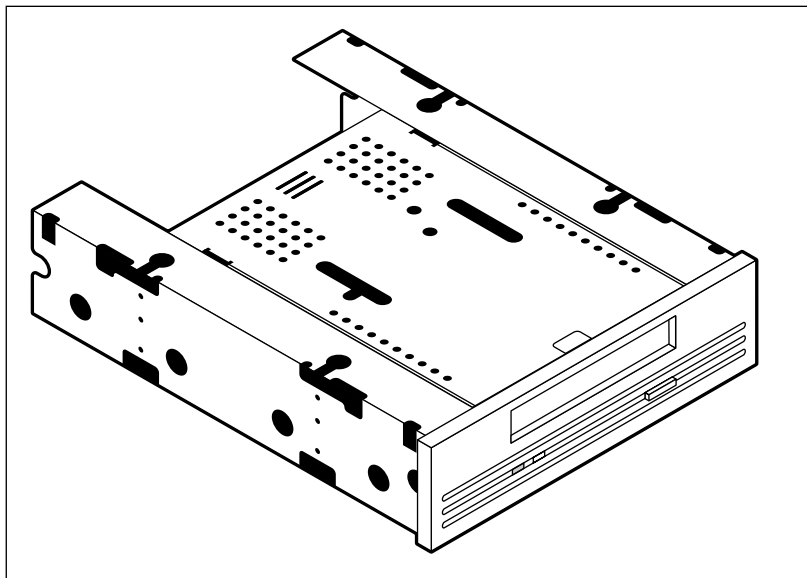
Figure 1-3
External DAT Drive
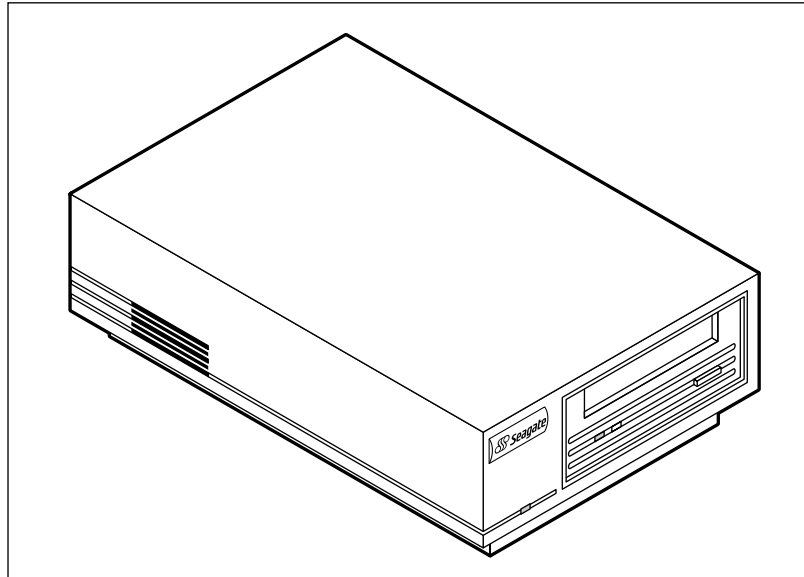
Features

The DAT drives embody Seagate's commitment to engineering reliable and durable tape drive products which implement leading-edge technology. In summary form, key features of these drives are:

- All DAT drives are based on 3.5-inch DAT drive components

- 3.5-inch internal form factor for installation in a 3.5-inch half-high space (Models STD12000N, STD14000N, and STD18000N)

- 3.5-inch DAT drive with factory-installed 5.25-inch mounting rails and bezel for installation in a 5.25-inch half-high space (Models STD22000N, STD24000N, and STD28000N)

- External subsystem with built-in, auto-sensing, worldwide power supply (Models STD62000N, STD64000N, and STD68000N)

- (8000 series only) capability to read and write DDS-2 narrow-track, 120-m cartridges

- (4000 and 8000 series only) advanced onboard DDS-DC hardware using DCLZ (Data Compression LempelZiv) data compression algorithm

- ANSI/ECMA DDS, DDS-DC (4000 and 8000 series), and DDS-2 (8000 series only) tape format compliance for compatibility and interchange

- Capability to read and write both DDS uncompressed and DDS-DC compressed data (4000 and 8000 series only) and data cartridges

- 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

- High speed, transfer rates for fast backups:

    - 550 KB/sec (33 MB/min) typical—uncompressed data
    - 1100 KB/sec (66 MB/min) typical—compressed data (4000 and 8000 series only)

- High performance SCSI burst transfer rate of 7 MB/sec asynchronous and 10 MB/sec synchronous

- Flash memory to store set-up 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 electrically upgradeable drive firmware

- Custom Seagate-designed LSI circuitry to reduce component count and boost drive reliability

- Advanced, single-chip, DAT 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

Typical System Configurations

The SCSI standard supports up to eight SCSI addresses or IDs. These IDs refer to host adapters or peripheral devices such as printers, magnetic disks, or tape drives. The eight devices or hosts are daisy chained together. Figure 1-4 shows sample configurations of SCSI systems.

Figure 1-4
SCSI System Sample Configurations
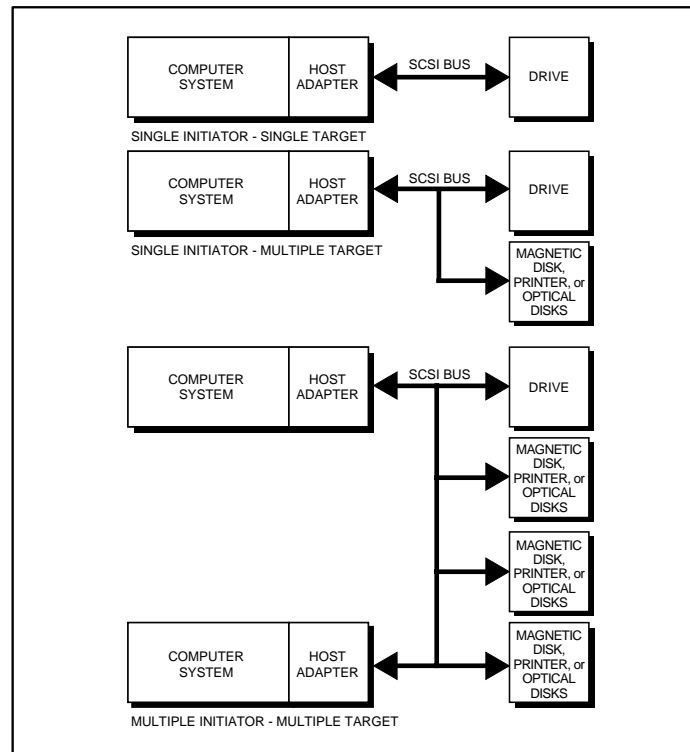
DAT Technology Overview

First 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 using 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 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.

Tape Formats

The Seagate DAT drives are designed to use the industry standard DDS, DDS-DC (4000 and 8000 series), and DDS-2 (8000 series only) tape formats. These formats are summarized in the following text.

DDS Tape 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; to facilitate data interchange; to provide compatibility with existing tape storage command sets; and to 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 with each data group being 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 Tape Format (4000 and 8000 series only)

A superset of the basic DDS DAT format, DDS-DC drives can write compressed and uncompressed data to the same cartridge. Thus, 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 DAT 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-correcting codes, and etc.) applied to a group before recording

- The tape layout

- The third group-based level of Reed-Solomon error-correcting codes (C3)

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

The combination of DAT technology and the DDS-DC format provides a solid core around which computer DAT drives with exceptional performance and reliability can be designed, such as the 4000 and 8000 DAT data compression products.

DDS-2 Tape Format (8000 series only)

The DDS-2, or narrow track, tape format provides for writing data in helical tracks that are narrower than the existing DDS track width. This format enables an increase of 50 percent more tracks on a cartridge. The 120-m cartridges designed especially for the DDS-2 format are made of a high-output, metal particle tape called MP+.

Data Compression—General

Data compression is based on reducing the redundancy that occurs naturally in data streams of text, graphics, code, and other data. Reducing or eliminating such redundancy prior to recording the information to tape significantly increases the amount of data that can be recorded on a given amount of tape.

Data compression causes repeated strings of data to be recognized and replaced by symbols or codewords that encode the strings or point back to the original

occurrence of the string. In this way, data compression uses fewer characters to represent the original data.

The Lempel-Ziv (LZ) algorithms are a family of string-based compression algorithms developed in the late 1970s by Messrs Lempel and Ziv. The DDS-DC and DDS-2 DAT drives use the DCLZ algorithm, which is based on a Lempel-Ziv algorithm that was enhanced by Welch. DCLZ builds a symbol dictionary that represents data strings identified as repeated events in incoming data. The algorithm then writes the symbols to the tape. This compressed data is then decompressed with the original data strings resubstituted for the symbols from the dictionary when the data is read back. (See chapter 7, **Data Compression**, for detailed information about the algorithm.)

Flash Memory

Another technological advancement incorporated into the drives is flash EEPROM, which is useful should the drive's SCSI firmware need to be upgraded at some point. With the permanently installed, electrically upgradeable, flash EEPROM memory, revised SCSI firmware for the drive can be loaded via any one of three methods:

- Seagate OEM firmware cartridge (See chapter 4.)

- Host SCSI bus

- Drive serial port (internal drives) (See chapter 8.)

This feature enables qualified OEMs needing to revise DDS-2 drive SCSI firmware to do so rapidly and at a reduced cost. Flash EEPROM should also prolong 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.

Software

One of the most cost-effective uses of DAT drives is to back up fixed disks. The software required to perform a disk backup runs under the control of the host computer's operating system. Compatibility with a wide range of software is also an important consideration in system integration. DAT drives are designed to take advantage of the host computer's standard magnetic tape backup software or, optionally, to use backup software provided by Seagate and other suppliers.

Standard DAT drives have been proven compatible with an exceptionally wide range of SCSI host adapters and interfaces, and network, operating system, and application software.

A major advantage of DDS-2 data compression is that it is software transparent. Software transparency means that, generally, no modification is required to network, operating system, application, and device driver software already proven compatible with Seagate DDS drives to run with DDS-DC products.

About This Manual

The remaining chapters and the appendices in this manual are briefly described in the following table. A glossary of terms is also included.

Number	Title	Description
2	Specifications	Contains physical, performance, environmental, power, drive tape handling, and DAT cartridge specification tables
3	Installation	Provides cautions, unpacking tips, inspection information, and installation/connection steps including cabling requirements and connector pinouts.
4	Drive Operation	Explains the simple operation of drives.
5	SCSI Interface	Lists general information about the SCSI-2 interface. (See NOTE below.)
6	Tape Formats	Explains the DDS, DDS-DC, and DDS-2 tape formats.
7	Data Compression	Describes the data compression algorithm and explains pertinent information for effective use of data compression.
8	Theory of Operation	Details the functional operation of various assemblies of the drives.
9	Maintenance and Reliability	Presents maintenance procedures and reliability information.
Appendix A	Glossary	Defines key terms.
Appendix B	Acronyms and Measurements	Lists the acronyms and measurements used in the manual.
Appendix C	Vendor Unique SCSI Information	Provides specific SCSI information for programming and retrieving configuration data.

▶ **Note:** This manual provides all technical information about the 2000, 4000, and 8000 DAT drives for hardware and software development and integration except complete SCSI information on the SCSI-2 commands themselves. Refer to the ***DAT Tape Drives and Autoloaders SCSI Manua**l (P/N 10002663-003) for detailed information about the SCSI interface, including a complete command summary.

Notes

Specifications 2

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 drives are listed in the following table.

▶ **Note:** Much of the operational and technical information is the same for the three models. Information specific to only one of the drive models is identified with the complete model number.

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 lbs/0.85 kg	2.4 lbs/1.1 kg	4.1 lbs/1.8 kg

Figures 2-1, 2-2, and 2-3 illustrate the drives showing the general dimensions of the internal and external models.

Figure 2-1
Internal DAT Drive—General Dimensions
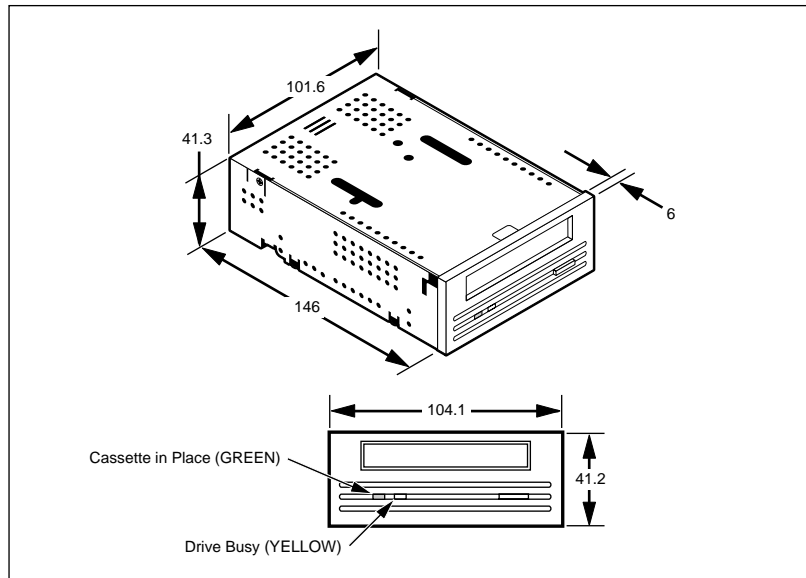
Figure 2-2
Internal DAT Drive with Rails—General Dimensions
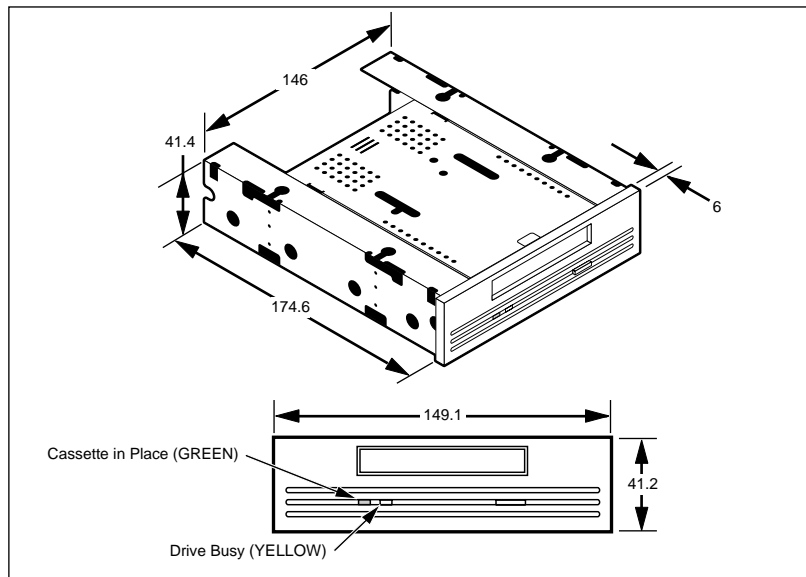
Figure 2-3
External Subsystem—General Dimensions
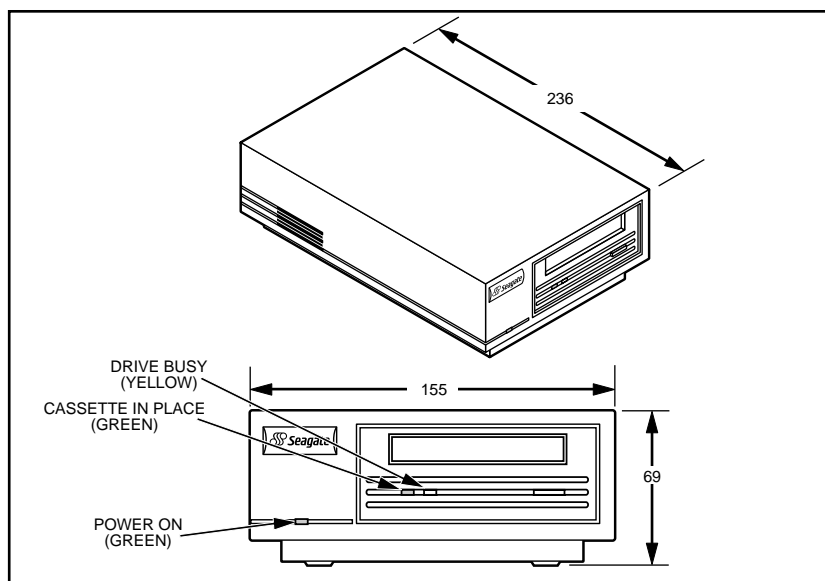
Power Specifications

The following table lists the power specifications for the internal drives. (Power specifications are measured at the tape drive power connector and are nominal values.)

Specification	Measurement	
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	<= 50 mV
Power dissipation (Nominal)	< 3.3 Watts	< 2.2 Watts

The following table lists pin assignments for 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		
	100 (Japan)	120 (US)	240 (European)
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 DAT drives.

Model	2000	4000	8000
Capacity			
60 m cartridge	1.3 GB	2.6 GB	2.6 GB
90 m cartridge	2.0 GB	4.0 GB	4.0 GB
120 m cartridge	—	—	8.0 GB
Recording density	61,000 bits/in.	61,000 bits/in.	61,000 bits/in.
Flux density	76,250 flux transfers/in.	76,250 flux transfers/in.	76,250 flux transfers/in.
Track density	1,869 tpi	1,869 tpi	2,804 tpi
Error recovery	Read-after-write Reed Solomon ECC (C3—3 levels)	Read-after-write Reed Solomon ECC (C3—3 levels)	Read-after-write Reed Solomon ECC (C3—3 levels)
Recording unrecoverable errors	< 1 in 10^{15} data bits	< 1 in 10^{15} data bits	< 1 in 10^{15} data bits
Tape drive type	Computer grade 4DD mechanism	Computer grade 4DD mechanism	Computer grade 4DD mechanism
Head configuration	2 read heads, 2 write heads	2 read heads, 2 write heads	2 read heads, 2 write heads
Recording format	DDS	DDS-DC	DDS-2
Recording method	Helical scan (R-DAT)	Helical scan (R-DAT)	Helical scan (R-DAT)
Cartridge	2.9 in. x 2.1 in. x 0.4 in.	2.9 in. x 2.1 in. x 0.4 in.	2.9 in. x 2.1 in. x 0.4 in.
Transfer rate (sustained)	550 KByte/sec	1100 KByte/sec DC ON	1100 KByte/sec DC ON
Synchronous transfer rate (burst)	10 MByte/sec max	10 MByte/sec max	10 MByte/sec max
Asynchronous transfer rate (burst)	7 MByte/sec max	7 MByte/sec max	7 MByte/sec max
Search speed	225 X normal speed	225 X normal speed	225 X normal speed
Average access time			
60 m cartridge	<20 sec	<20 sec	<20 sec
90 m cartridge	<30 sec	<30 sec	<30 sec
120 m cartridge	—	—	<40 sec
Drum rotation speed	6000 RPM	6000 RPM	6000 RPM
Tape speed	0.96 in./sec	0.96 in./sec	0.96 in./sec
Head-to-tape speed	372 in./sec	372 in./sec	372 in./sec

Environmental Requirements

The following table lists the environmental specifications for DAT drives. The internal DAT drives may be mounted 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/minute (no condensation)	Below condensation
Relative humidity	20% to 80% noncondensing[1]	0% to 90% noncondensing[2]
Maximum wet bulb temperature	78.8^{o}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) 0.73 g peak (17 to 150 Hz) 0.50 g peak (150-500 Hz)	— — —
Sweep Rate	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 g's peak, 11 msec	50 g's peak, 11 msec

[1]Mechanism and media   [2]Mechanism

DAT Cartridge Specifications

DAT drives provide maximum data integrity and reliability when Seagate-qualified DAT cartridges are used as the recording medium. Seagate maintains an ongoing program to qualify manufacturers of DAT 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 cleaning cartridge: Model M91301

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

Regulatory Compliance

These DAT 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
VDE	0871, Class B

[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 (SEC) for UL and CSA and Safety Extra Low Voltage for BSI and VDE (if applicable).

Installation 3

Introduction

This chapter tells you how to install the DAT drives. Some of the information relates to all drives; 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 drives.

- **Unpacking and Inspection** contains general information that you should read before you begin the installation.

- **Cabling and Connectors** gives specific cabling requirements and connector pinouts for the drives.

- **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 internal drives. Keep them in mind as you install the drive.

- Because internal drives contain components that are sensitive to static electricity, the drives are shipped in a protective anti-static bag. DO NOT remove the drive from the anti-static bag until you are ready to install it.

- Before you remove the drive from the anti-static bag, touch a metal or grounded surface to discharge any static electricity buildup from your body.

> ⚠ **Caution:** .If you touch static-sensitive parts of the drive, such as a printed circuit board, and discharge static electricity, the components might be damaged.

- Hold the drive by its edges only and avoid direct contact with any printed circuit board exposed.

- Lay the drive only on top of the anti-static bag or return it to the bag when you need to lay it down.

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; 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. Save the containers and packing materials for any future reshipment.

Cabling and Connectors

The drives provide standard single-ended SCSI transmission. ANSI SCSI standards specify the technical requirements for correctly cabling and connecting single-ended devices. This section provides information about SCSI cabling and connectors for the drives.

The actual installation instructions are given later in this chapter.

Cabling Considerations

Either 50-pin flat cable or 25-signal twisted-pair cable with a maximum length of 6 meters (19 feet) may be used 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 not be less than 90 ohms nor greater than 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 mm^2).

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 (+ or -5%) to TEMPWR

and 330 ohms (+ or -5%) to GROUND and must meet the following specifications:

● Terminators must supply a characteristic impedance of 100 to 132 ohms.

● External terminators must be powered by the TEMPWR line, and units providing terminator power to the cable must have:

   V_{TERM} = 4.25 to 5.25 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 drives provide 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
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 drives provide 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 1-12 and 14-25 are connected to ground. Pin 13 is left 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 the Internal Drives

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

Installing these two drives consists of a few easy steps:

1. Configure 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 configure the drive options by setting switches and setting jumpers. The directions for setting both switches and jumpers are given in the following subsections.

Setting Operational Switches

Set the switches before you install the drive in the computer. Figure 3-1 illustrates the switchbank location for the 3.5-inch internal drive (view of the bottom of the drive).

Figure 3-1
Switchbank Access—3.5-Inch Drive

POWER
CONNECTOR

PIN 1

SCSI
CONNECTOR

JUMPER
BLOCK
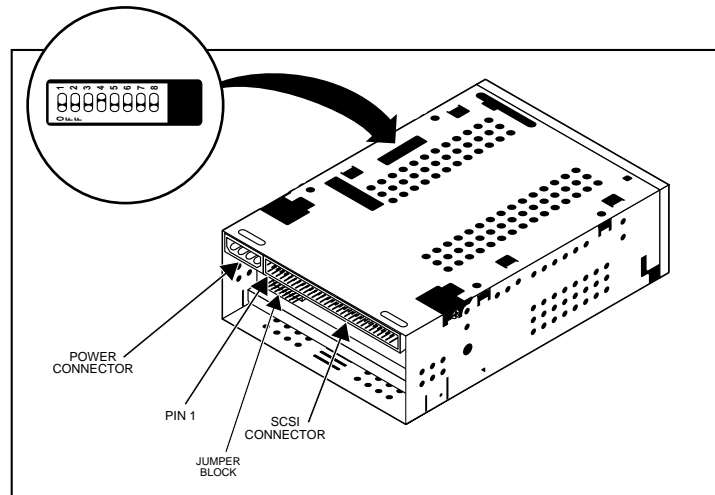
Figure 3-2 illustrates the switchbank location for the 5.25-inch internal drive (view of the bottom of the drive).

Figure 3-2
Switchbank Access—5.25-Inch Drive

POWER
CONNECTOR

PIN 1

SCSI
CONNECTOR

JUMPER
BLOCK
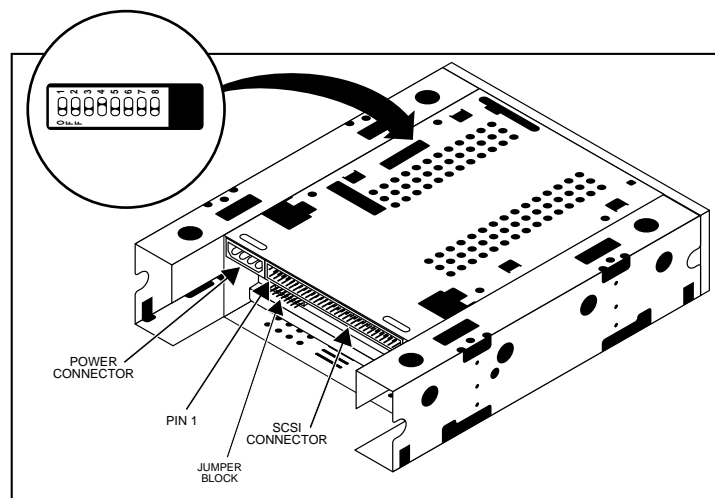
These switches allow you to set up the following configuration options:

● SCSI device address (S1 through S3): Default = SCSI ID 0 (S1 through S3 = OFF)

● Media Recognition System (MRS) mode (S4):
  Default = MRS OFF (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)

▶ **Note:** When S6 is OFF, DDS-DC data compression is ENABLED. When S6 is ON, DDS-DC data compression is DISABLED. (**4000 and 8000 series drives only**)

- Power-on self-test enable/disable (S8):
  Default = Power-on self-test disabled (S8 = OFF)

Figure 3-3 shows the default settings for the internal drives.

Figure 3-3
Dip Switch Default Settings

	S8	S7	S6	S5	S4	S3	S2	S1	
	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
						OFF	ON	OFF	2
ON	Enable	Seagate	DDS	Enable	All	OFF	ON	ON	3
						ON	OFF	OFF	4
						ON	OFF	ON	5
						ON	ON	OFF	6
						ON	ON	ON	7

▶ **Note:** The drive must be turned OFF; then, ON in order for switch settings to take effect, or a SCSI Bus Reset must be received.

If the default settings are correct for your system, go to **Mounting the Drive Unit**. DDS-DC data compression enabled (S6 = OFF) is also set as a factory default.

If you need to change any default settings, refer to the appropriate following section; make the changes and then go to **Mounting the Drive Unit**.

SCSI Device Address (S1 through S3)

The three switches S1 through 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)

The S4 switch enables or disables Media Recognition System (MRS) mode. The default is MRS disabled (S4 = ON). If S4 is ON, the drive reads or writes 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, and the Sense Key will be 07, Data

Protect. The additional Sense Code and qualifier will be 30/00, Incompatible Media Installed. The drive reads any kind of 4-mm media when S4 is OFF.

S4 = ON disables MRS
S4 = OFF enables MRS

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)(4000 and 8000 Series Only)

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

► **Notes:** 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. When being read by the drive, DDS-DC compressed data is always decompressed, regardless of the position of S6.

The function of the S6 switch can be over-ridden by the proper SCSI **MODE SELECT** command issued from the host computer. Regardless of the position of S6, the **MODE SELECT** command can enable or disable data compression.

Inquiry String (S7)

The S7 switch is used to select the SCSI inquiry string. The normal setting is to enable the Seagate inquiry string. It can be set to Archive to provide compatability with older backup software.

S7 = ON enables Seagate inquiry string
S8 = 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 diagnostics when the power comes ON. The default is power-on self-test mode disabled (S8 = OFF). If ON, the drive responds to SCSI commands after successful completion of the test (about 5 seconds).

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

Configuring Jumpers

Pins 1-6 on the jumper block can be used for remote SCSI address selection where the unit is installed in a standalone enclosure. S-1 through S-3 on the DIP switch must be in the OFF position. Figure 3-4 illustrates the location of the jumpers for the internal drive.

Figure 3-4
Location of Jumpers for Internal Drive
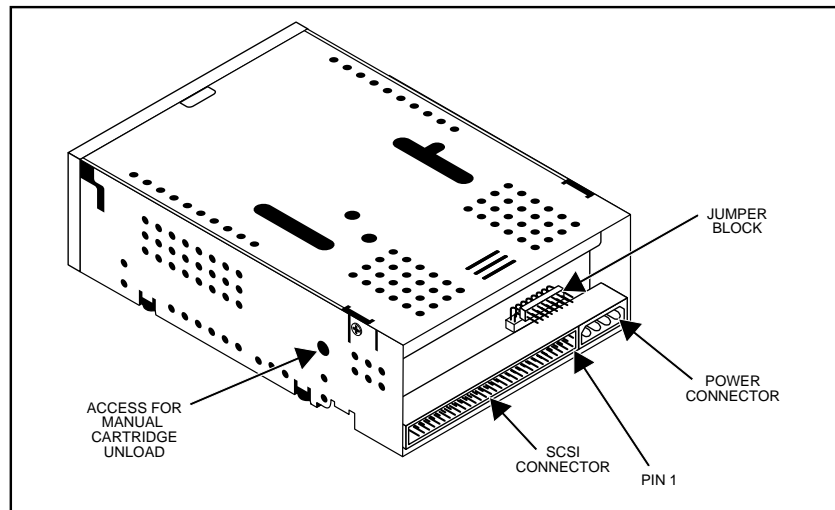
Figure 3-5 illustrates the location of the jumpers for the internal drive with rails.

Figure 3-5
Location of Jumpers for Internal Drive with Rails
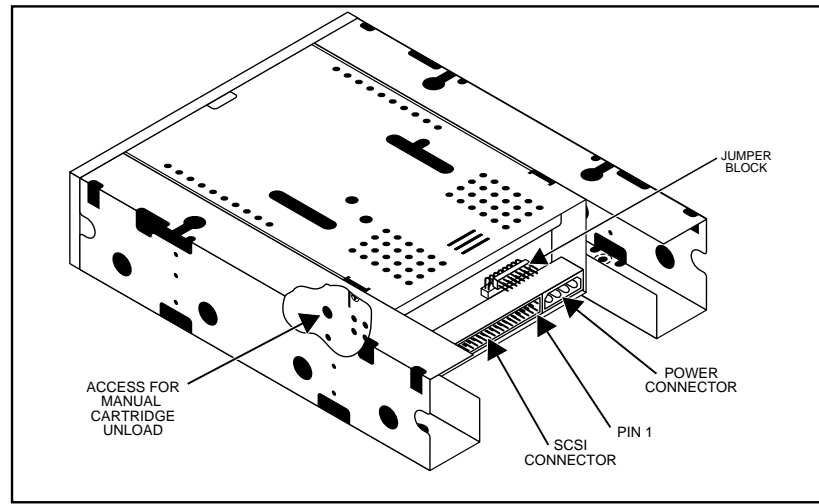
The following configuration is the standard default setup:

- SCSI ID0

- The drive reads or writes both MRS and non-MRS 4-mm media.

- Parity is disabled.

- DDS-DC data compression is enabled. **(4000 and 8000 series only)**

- The power-on self-test diagnostics of the drive are disabled.

- Terminator power is disabled.

- Active terminator is disabled.

▶ **Note:** Some configuration settings can be changed using the Mode Select command. Refer to Appendix C for specific SCSI information.

Unless the drive is to be SCSI ID0, you use the jumpers to set the SCSI device address.

Optionally, you can use the jumpers to override the default settings in the Configuration EEPROM. You can change the following options using the jumpers:

● Data compression enabled or disabled

● Power-on self-test diagnostics enabled or disabled

● Active terminator enabled or disabled

● Terminator power enabled or disabled.

Figure 3-6 shows the jumper configurations for the various SCSI device addresses (IDs) and for the other options.

Figure 3-6
Jumper Configurations
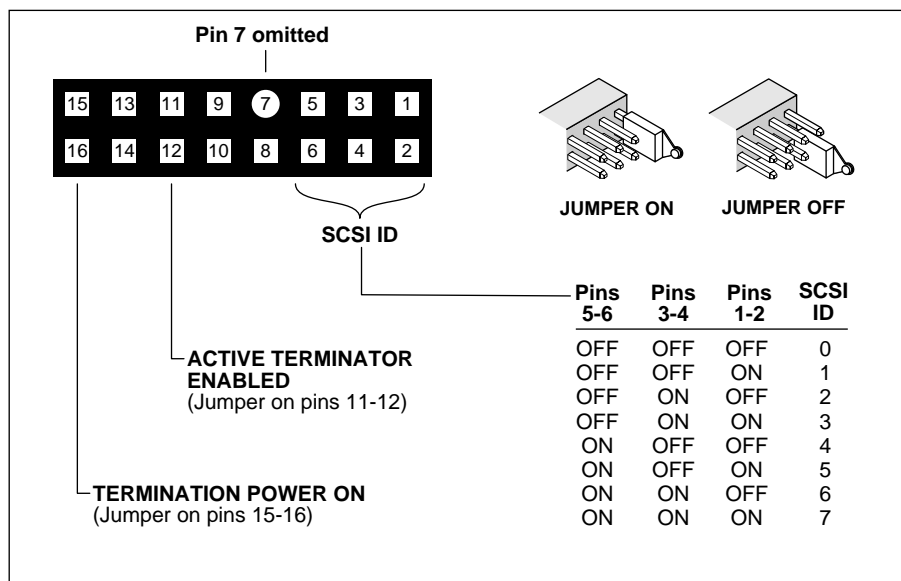
> ▶ **Note:** The drive must be turned OFF; then, ON in order for the jumper placements to take effect, or a SCSI Bus Reset must be received.

If the default address setting ID0 is correct for your system, and you do not choose to change any other options, go to **Mounting the Drive Unit**.

If you need to change any default settings, refer to Figure 3-3 and the appropriate following section; make the changes and then go to **Mounting the Drive Unit**.

SCSI Device Address Jumpers

The three jumper locations for ID0, ID1, and ID2 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.

Active Terminator

The active terminator option is disabled as the factory default programmed into the EEPROM. If you need to have an active terminator for the drive, place a jumper on pins 11 to 12.

▶ **Note:** You need to enable the active terminator option if the drive is the only device on the SCSI bus or is the last device on the bus.

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 internal DDS-2 drives is with terminator power disabled (jumper shunt over one pin). To enable terminator power, place the jumper shunt over the two pins—15 and 16—as shown in Figure 3-6. Be sure the jumper shunt is firmly in place.

⚠ **Caution:** If the jumper is installed, be careful not to short the TERMPWR signal to ground.

The drive contains a terminator power fuse to prevent damage to drive components in case the terminator power is shorted. If terminator power is enabled and the SCSI cable is connected upside down for example, this fuse may blow to prevent damage to the drive itself. In that case, return the drive to an authorized repair facility.

Terminator Power

At the rear of the drive, a 2-pin header allows you to enable +5-volt terminator power if needed for terminators or other SCSI devices. The factory default for internal drives is with terminator power disabled (jumper shunt over one pin). To enable terminator power, place the jumper shunt over the two pins. (See Figure 3-6 for the correct location based on your drive type.) Be sure the jumper shunt is firmly in place.

⚠ **Caution:** If the jumper is installed, be careful not to short the TERMPWR signal to ground.

The terminator power fuse is located beside the terminator power jumper to prevent damage to drive components in case the terminator power is shorted. If terminator power is enabled and the SCSI cable is connected upside down for example, this fuse may blow to prevent damage to the drive itself. In that case, return the drive to an authorized repair facility.

Mounting the Drive Unit

The internal drives can be installed in three different orientations: one horizontally (eject button right) and two vertically (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 3-7.

Figure 3-7
Mounting Hole Locations (internal drive without rails)
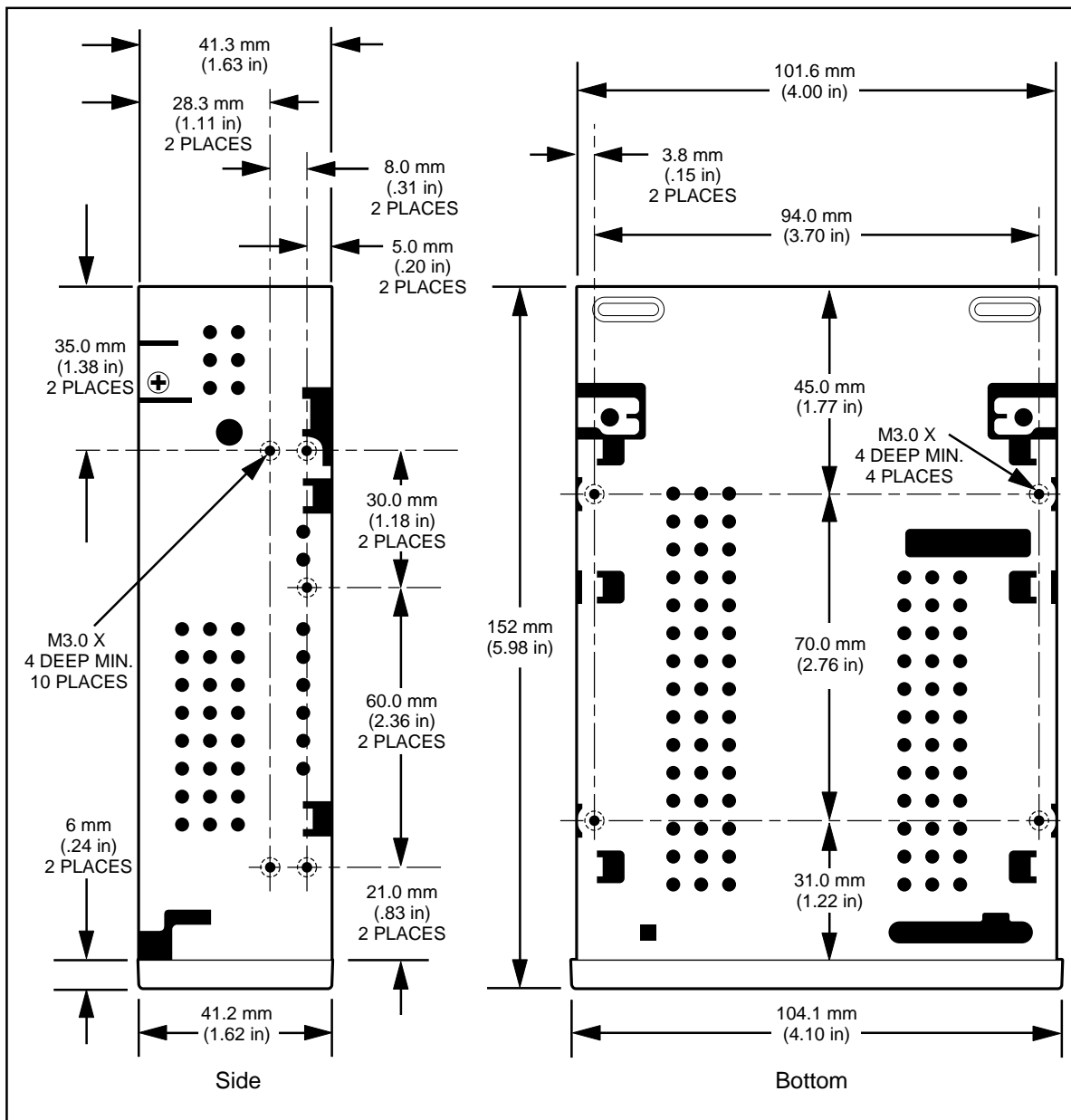
Side   Bottom

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 3-8.

Figure 3-8
Mounting Hole Locations (internal drive with rails)
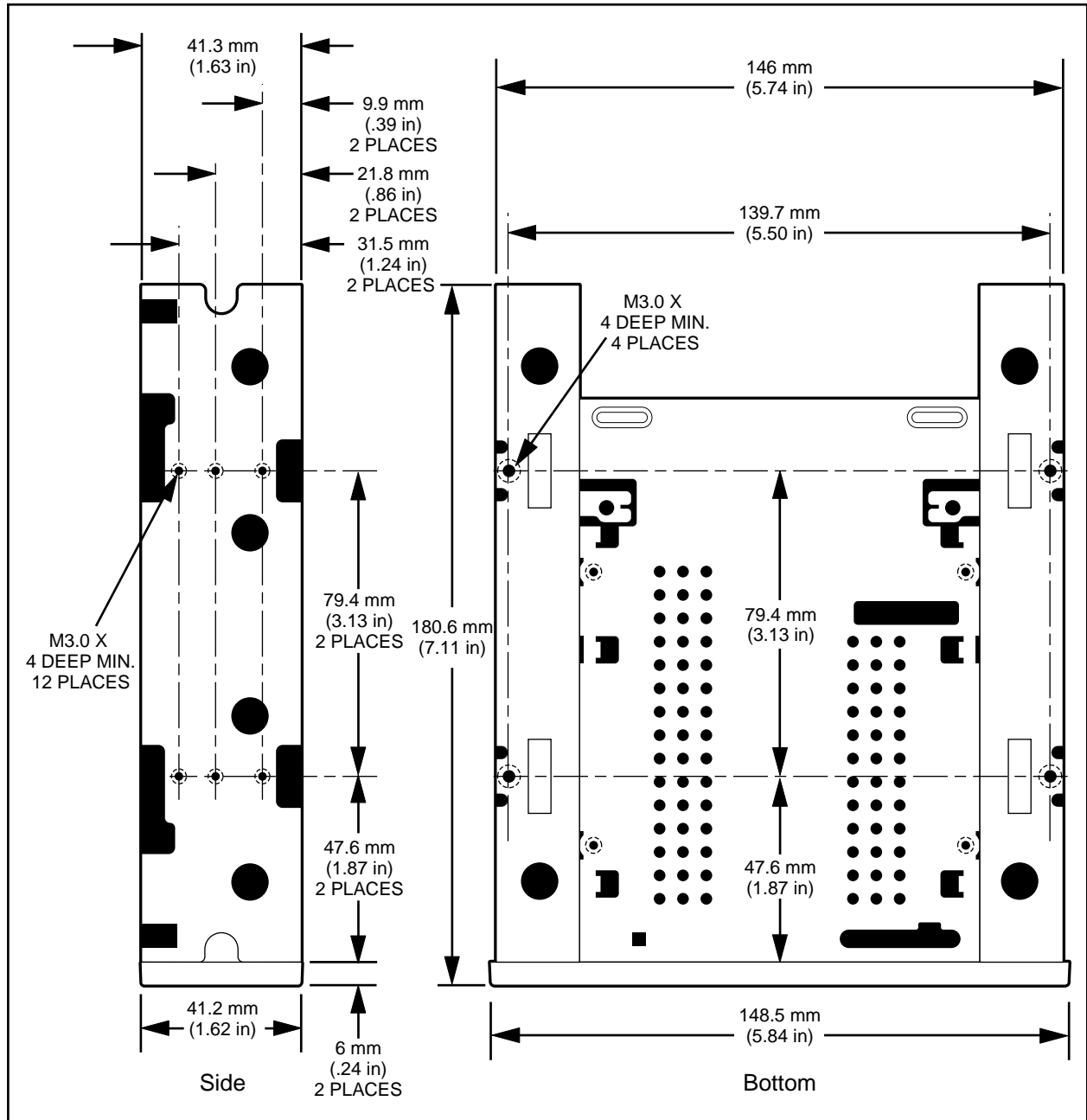
Completing Connections

The power and interface connectors for the internal drives are located at the back of the drive unit. Figure 3-4 illustrates these connections for the internal drive and Figure 3-5 illustrates these connections for the internal drive with rails.

▶ **Note:** Turn off all power before inserting connectors. Pin 1 on the SCSI connector is to your right as you look at the back of the drive. (See Figures 3-4 and 3-5.) Your SCSI cable should have Pin 1 highlighted by a color strip. Be sure to mate Pin 1 on the cable to Pin 1 on the drive. Failure to do so could make the drive inoperative.

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

● The mating interface connector for the internal drives is a single-ended connector as described earlier in this chapter. When you make the connection, be sure pin 1 of the connector aligns with pin 1 on the SCSI connector. (See Figures 3-4 and 3-5.)

Installing External Drives

The compact external drive connects as a turnkey subsystem to the computer. The drive may be operated vertically or horizontally. The following configuration is the standard default setup:

● The drive reads or writes both MRS and non-MRS 4-mm media.

● Parity is disabled.

● DDS-DC data compression is enabled. **(4000 and 8000 series only)**

● The power-on self-test diagnostics of the drive are disabled.

● Terminator power is supplied to the SCSI bus

▶ **Note:** Some configuration settings in the flash EEPROM can be changed using the Mode Select command. Refer to Appendix C for specific SCSI information.

Installing these drives consists of a few easy steps:

1. Select SCSI address.

2. Complete the interface connection.

3. Complete the power cord connection.

Selecting the SCSI Address

The rear panel of the external drive unit contains the SCSI address selection push switch, the two interface connectors, the ON/OFF switch, and the power cord connection. Figure 3-9 illustrates the rear panel.

Figure 3-9
Rear Panel (External Models)
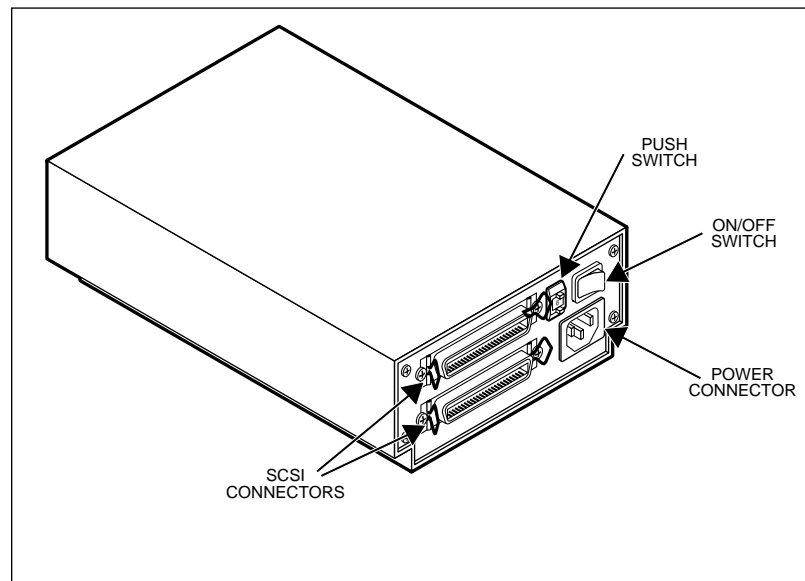
Locate the SCSI address push switch. Select the SCSI address for the drive by pressing the + or - button until the desired address (0 through 7) appears in the window. Turn the unit power OFF; then, ON.

Completing the Interface Connection

The external drive provides two SCSI connectors to allow daisy chaining. (See Figure 3-10.) Either connector can connect to the host computer or any SCSI device in a daisy chain.

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

● When the drive is the last drive in the chain (or the only drive), a single interface cable is attached to one connector, and a terminating plug is installed in the other connector. (Seagate P/N 38-9-74000000)

● When the drive is within the chain, the interface cable from the preceding device is connected in one connector; an interface cable is also connected from the other connector to the following device. In this case, no termination is required.

Figure 3-10 illustrates these daisy-chain connections

Figure 3-10
Daisy Chain Diagram
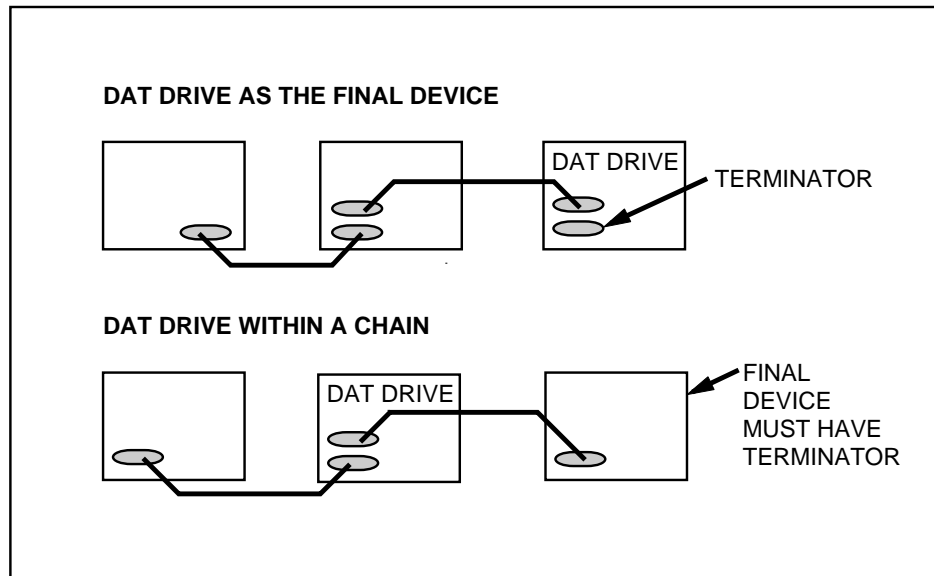
The same type of mating connector is used for either of the daisy-chain connections. The mating interface connector for the external drive is a single-ended connector as described earlier in this chapter.

Connecting the Power Cord

See Figure 3-9 for the location of the power cord connector. Insert the power cord mating connector into the connector on the rear panel. Be sure the connection is secure. Plug the other end of the power cord into an electrical outlet power strip, a continuous power supply, or a wall receptacle.

Drive Operations 4

Introduction

This chapter describes important operational procedures for the DAT drives. It covers the following topics:

● Data compression operation

● Operation of the front panel LEDs

● Loading and unloading a cartridge

● Using a blank cartridge

● Using a cartridge with data on it

● Using a prerecorded audio cartridge

● Loading revised SCSI firmware

▶ **Note:** Required drive maintenance including using a cleaning cartridge is explained in Chapter 9.

Data Compression Operation (4000 and 8000 Series)

Default operation for the drives with data compression capability is with data compression enabled—the drive automatically compresses all data written to tape and decompresses all compressed data read from tape, in DDS-DC format. Data with high degrees of redundancy, such as structured database 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 least.

To switch between compressed mode (writing compressed data, DDS-DC format) and noncompressed mode (writing uncompressed data, DDS format), the host computer executes a SCSI **MODE SELECT** command.

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

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 being read.

Front Panel LED Operation

The front panel of the drives contains two rectangular LEDs. The yellow rectangular LED indicates the drive status; the green LED, the cartridge status. These two indicators provide operating information for normal as well as error conditions.

The external subsystem also contains a round, green power-on LED on the front panel.

The Drive Status LED is yellow and indicates the following conditions:

● When ON (lit), the drive is reading or writing the tape. (SCSI or DAT activity is present.) During a SCSI **PREVENT MEDIA REMOVAL** command, the LED is always ON.

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

● 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:** Some guidelines for operation in high humidity conditions are listed in chapter 9.

The green, rectangular Cartridge Status LED indicates the following conditions:

● When ON (lit), a cartridge is inserted and does NOT generate excess errors.

● When flashing slowly, a cartridge is inserted but generates excess errors beyond a predefined DDS error threshold. This signal is a warning only and does not indicate data loss. First, clean the drive heads using an approved DDS DAT cleaning cartridge (such as the Seagate Model M7301).

If the LED continues flashing or flashes when ejecting the cartridge, use a new cartridge for future writes. Otherwise, operation is proceeding normally.

▶ **Note:** As routine maintenance, the drive heads should be cleaned after every 25 hours of operation. See chapter 9 for more information about maintenance.

● When flashing slowly in conjunction with the yellow LED, a prerecorded audio cartridge is inserted and is being played automatically.

● 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 DDS DAT cleaning cartridge, such

as the Seagate Model M7301. If the LED continues flashing, use a new cartridge for future writes.

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

Figures 4-1, 4-2, and 4-3 show the front panels of the internal and external drives.

Figure 4-1
Front Panel—Internal Model
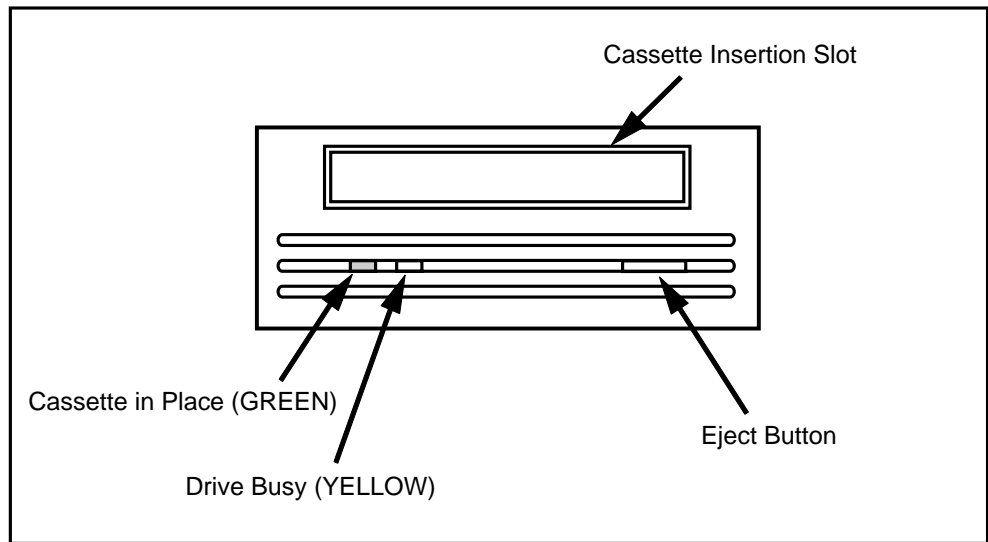
Figure 4-2
Front Panel—Internal Model with Rails
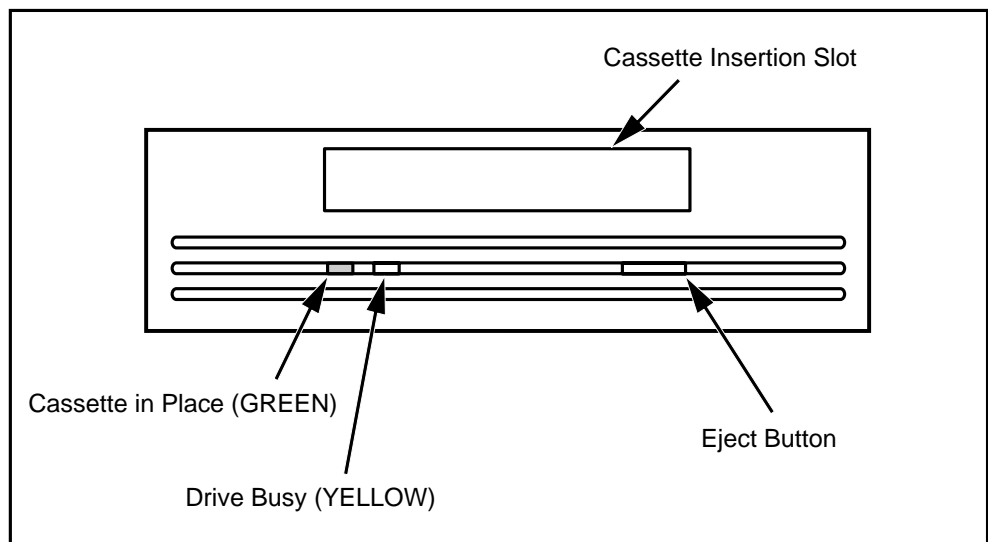
Figure 4-3
Front Panel—External Subsystem
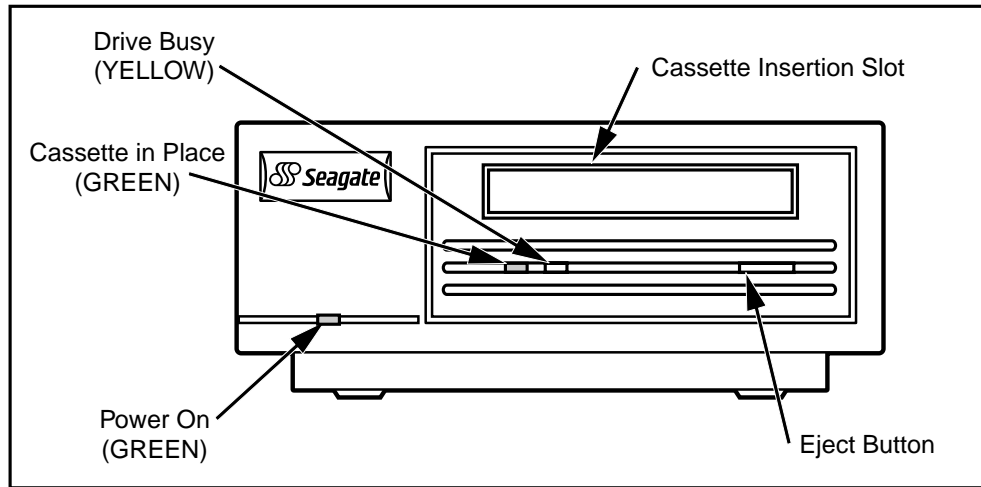
The following table summarizes the operation of the front-panel LEDs. See the previous explanations to remedy fault conditions.

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 NOT generate excess errors.
Green	Flashing Slowly	A cartridge is inserted but generates excessive errors beyond a predefined error threshold. (Warning only) *Use a DDS cleaning cartridge to clean the heads.*
Green	Flashing Slowly (with yellow LED flashing)	A prerecorded audio cartridge is inserted and is being played automatically.
Green	Flashing Rapidly	The drive could not write the tape correctly. (Error) *Use a DDS DAT cleaning cartridge to clean the heads.*
Green, round (External drives)	ON (lit)	The external drive is powered on.

Loading/Unloading the Cartridge

The cartridge insertion slot on the front panel of the DAT drives 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)

These drives have a front-loading cartridge insertion mechanism that allows the operator to easily load the cartridge by pushing against the middle part of the cartridge opening until it is fully recessed into the cartridge insertion slot. Insert the cartridge with the arrow on the top of the cartridge entering the slot first. Figure 4-4 illustrates cartridge loading (internal drive shown).

Figure 4-4
Cartridge Loading (Internal DAT Drive)
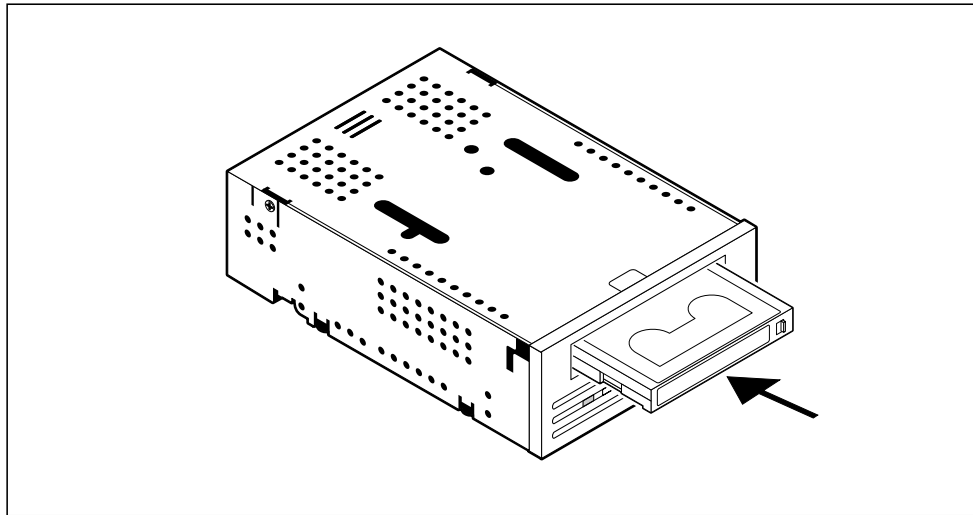
You unload the cartridge by pressing the eject (tape unloading) button on the front panel. (See Figures 4-1, 4-2, and 4-3 of the front panels for the location of the eject button for your drive.) Once you press the eject button, the drive updates the system log with a running count of drive/tape "soft" errors, rewinds the tape, and then ejects the cartridge. It is partially ejected and can then be easily removed 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 during this time.

Unloading a Cartridge (Manual Operation)

If a power outage occurs while a cartridge is loaded or the automatic removal 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.

▶ **Note:** This procedure is basically the same for all form factors—only the physical housings are different. You will need a small, precision screwdriver.

1. Disconnect power to the computer; then disconnect the unit from the computer. That is, remove the SCSI connections to the host computer.

2. Remove the power connections. For internal models, disconnect the power connection with the host computer. For the external drive, remove the power cord from the drive.

3. For internal drives, remove the drive from the computer.

For the internal drive, remove the top cover by removing the two screws at the top edge near the rear of the unit (one on each side). Retain the screws. (See A in Figure 4-5.) Then remove the front bezel by pulling out on the top of the bezel at the indentation. (See B in Figure 4-5.)

For the internal drive 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 top cover of the drive unit by removing the two screws at the top edge near the rear of the unit (one on each side). Retain the screws. (See A in Figure 4-5.) Then remove the front bezel by pulling out on the top of the bezel at the indentation. (See B in Figure 4-5.)

Figure 4-5
Locations on Drive Unit
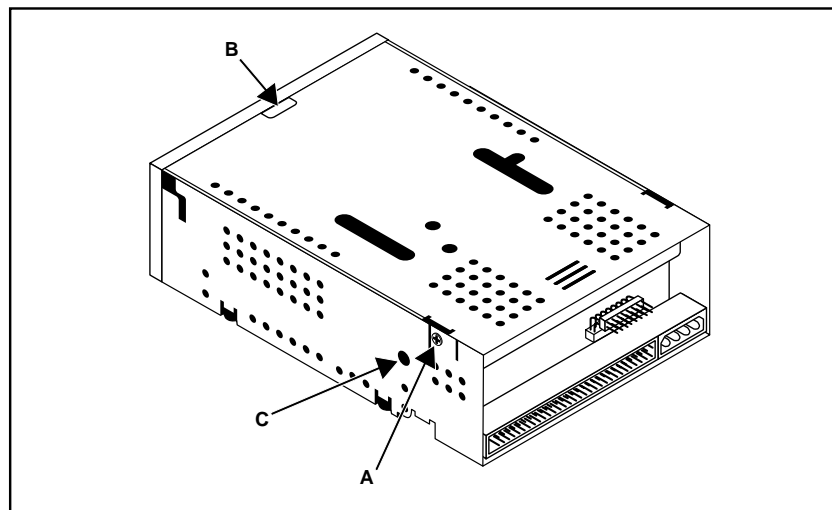
For the internal drive, turn the unit upside down and remove the four screws (two screws on each side) that attach the external cover to the chassis unit. Remove the exterior cover and retain the screws. On the drive unit inside the chassis, remove the top cover by removing the two screws at the top edge near the rear of the unit (one on each side). See A in Figure 4-5.

4.   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 4-5).

▶   **Note:** Do NOT turn the mode motor shaft counterclockwise. Turning the shaft counterclockwise might 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.

5.   Replace the top cover on the drive and secure it with the two screws that you removed.

6.   For internal models, replace the front bezel (internal models) by angling the two plastic feet at the bottom of the bezel in and aligning 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.

7.   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 DDS-2 or DDS 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 causes writing to the tape.

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

If the first **WRITE** command stores less than 126 kilobytes of data, the data is placed in the buffer until the next WRITE command exceeds the 126-kilobyte buffer capacity and forces the stored data to actually be written to tape.

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

1.   Gently push the blank DAT 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 4-4.)

     Once the cartridge is partially inserted, the drive mechanism automatically completes the cartridge insertion and proper positioning.

     The yellow and green rectangular LEDs on the front panel go ON as the drive checks the cartridge to determine its state (blank, write-protected, prerecorded audio, firmware update, and etc.) and positions to the data area, which 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 backup application software. The drive begins initializing the tape before completing the backup (WRITE) operation. WRITE operations are completed during the initializing operation without delay until all internal buffers are filled.

3.   After completing the backup and after 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 is then emptied to tape, and the tape is rewound.

     The data buffer of the drive is also emptied to the tape in these three cases:

     ● A **REWIND** command is issued.

     ● The eject button is pushed.

     ● A delay as defined by **MODE SELECT** or the one-minute default delay time in which no activity occurs.

Before the drive ejects the cartridge it automatically updates the system log, which requires a few seconds; then it rewinds and ejects the cartridge. When ejected, the cartridge is pushed out of the cartridge insertion slot to a half-way position for easy removal.

Using a Cartridge Containing Data

The sequence for writing a cartridge that already contains data is similar to the blank cartridge sequence except the cartridge is not automatically initialized by the drive. A brief delay occurs when the cartridge is first inserted as the drive identifies the cartridge type and state, and positions to the data area.

Loading Revised Firmware via Seagate Firmware Cartridge

These drive models use flash memory. Flash memory enables you to download new firmware when revisions to firmware are released. Firmware revisions are released on specially encoded cartridges that are automatically recognized by these drives. These firmware revisions are available for qualified OEMs only from Seagate Peripherals, Inc.

To load a firmware upgrade tape, follow these steps.

1. Power on the host system with the DAT drive installed.

2. Insert the firmware upgrade cartridge.

3. The drive automatically recognizes the tape and loads the new firmware. This process takes about 30 seconds. The drive automatically ejects the cartridge once the firmware is loaded. No LEDs are illuminated if the firmware loaded correctly.

▶ **Note:** Once the firmware upgrade cartridge is inserted in the drive, it is important that no power interruption occurs while the firmware is loading. DO NOT POWER OFF THE DRIVE AT THIS TIME. If a power interruption occurs, the firmware may not be loaded correctly, and the drive may not operate properly.

If a problem occurs during the firmware loading process, the cartridge is ejected, and the yellow LED on the front panel flashes. In that case, the firmware upgrade cartridge may be defective, or the drive may not be operating correctly.

If after a repeat loading of the firmware cartridge, the same condition is observed, contact your Seagate sales representative.

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

Revised firmware can also be loaded into EEPROM using the SCSI **WRITE DATA BUFFER** command. Refer to chapter 8 for more information about flash memory.

NOTES

SCSI Interface

5

Introduction

The DAT drives provide an embedded Small Computer System Interface (SCSI) controller for communications between the host computer and the DAT drive. These drives support the SCSI-2 (ANSI X3.131, 199x) interface.

The SCSI-2 interface provides a modified MODE SENSE page to control and report on data compression operations. Data compression can also be enabled and disabled by software (**MODE SELECT** command), which overrides the DIP switch setting.

These drives provide a single-ended SCSI connection. This chapter summarizes the SCSI-2 status codes, message codes, and commands. Refer to chapter 3 for specific SCSI cabling and connector information.

Refer to Appendix C for specific SCSI information about reading from and writing to the configuration EEPROM.

▶ **Note:** Refer to the ***DAT Tape Drives and Autoloaders SCSI Manual*** (P/N 10002663-00x) for detailed information about the SCSI interfaces. That manual includes an alphabetically arranged summary of the SCSI commands.

SCSI-2 Interface

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

		4-bit Status Code				
Bits	*4*	*3*	*2*	*1*	*0*	*Definition*
	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

Code	*Description*	*Direction*[*]
00h	Command Complete	In
02h	Save Data Pointer	In
04h	Disconnect	In
05h	Initiator Detected Error	Out
06h	Abort	Out
07h	Message Reject	In/Out
08h	No Operation	Out
0Ah	Linked Command Complete	In
0Bh	Linked Command Complete with Flag	In
0Ch	Bus Device Reset	Out
80h	Identify (No Disconnect/Reconnect)	In/Out
C0h	Identify (Disconnect/Reconnect)	In/Out
01h[**]	Extended Message	In/Out

[*] Direction: In = Drive to host; Out = Host to Drive.

[**] Supports only one extended message: SYNCHRONOUS DATA TRANSFER REQUEST.

Code	Type	Command
00h	M	TEST UNIT READY
01h	M	REWIND
02h	V	REQUEST BLOCK ADDRESS
03h	M	REQUEST SENSE
05h	M	READ BLOCK LIMITS
08h	M	READ
0Ah	M	WRITE
0Ch	V	SEEK BLOCK
10h	M	WRITE FILEMARKS
11h	M	SPACE
12h	M	INQUIRY
13h	O	VERIFY
15h	M	MODE SELECT
16h	M	RESERVE UNIT
17h	M	RELEASE UNIT
19h	M	ERASE
1Ah	M	MODE SENSE
1Bh	O	LOAD/UNLOAD
1CH	O	RECEIVE DIAGNOSTIC RESULTS
1Dh	M	SEND DIAGNOSTIC
1Eh	O	PREVENT/ALLOW MEDIUM REMOVAL
2Bh	O	LOCATE
34h	O	READ POSITION
3Bh	O	WRITE DATA BUFFER
3Ch	O	READ DATA BUFFER
40h	O	CHANGE DEFINITION
4Ch	O	LOG SELECT
4Dh	O	LOG SENSE

M = Mandatory Comman   O = Optional Command

E = Extended Command   V = Vendor Unique Command

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

GENERAL FEATURES

1. Disconnect/reconnect, arbitration (required in SCSI-2).
2. Single-ended drivers.
3. Termination power supplied to cable (jumper option).
4. Supports both single and multi-initiator systems.
5. Fixed and variable block transfer lengths.
6. Hard reset.
7. Synchronous data transfers
8. Parity implemented (switch option).
9. Space blocks, filemarks, and EOD.
10. Supports third-party reservation.
11. Log Sense and Log Select for managing soft errors reporting.
12. 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.

Tape Formats 6

Introduction

The DAT drives with data compression capabilities (4000 and 8000 series drives) use the ANSI Digital Data Storage (DDS) and Digital Data Storage Data Compression (DDS-DC) tape formats to record uncompressed and compressed data on Digital Audio Tape (DAT) media. The DDS-DC format is a superset of the DDS format, thus ensuring compatibility and allowing the DDS-DC drives to write compressed and uncompressed data to the same DDS DAT cartridge.

As a superset of the DDS format, the DDS-DC format adds support for in-drive data compression and decompression. The features of this format were conceived for use with lossless compression algorithms based on substitution; however, the format is not necessarily limited to those algorithms. The implementation of data compression in the drives uses the advanced DCLZ (data compression LempelZiv) algorithm.

The industry standard DDS-DC format has been approved by the DDS Manufacturers Group, ANSI, and ECMA.

The 8000 series drive also reads and writes the Digital Data Storage-2 (DDS-2) format to 120-meter MP+ cartridges. This narrow-track format allows 50 percent more tracks to be written to the tape. These narrow-track cartridges use the media recognition system (MRS). The MRS is briefly explained later in this chapter.

This chapter describes these tape formats. Basically, the DDS-2 format is the same as the DDS and DDS-DC formats except that the DDS-2 format is for narrow track tape.

DDS Format

The DDS format supports DAT devices as computer peripherals. The objectives of the DDS format are:

- To maximize storage capacity and performance

- To facilitate data interchange

- To provide compatibility with existing storage command sets

- To provide extremely fast random access

- To take advantage of the helical scan recording method

- To augment the inherent error-detection and error correction capabilities of the DAT technology

Achievement of these objectives is shown in the following list of advantages provided by the DDS format.

- Maximizes capacity and transfer rate.

- Supports SCSI sequential command set functions.

- Supports random read functions.

- Supports both variable-length and fixed-length records.

- Supports two independently-writeable partitions to support directory of stored data. (Host determines whether tape is single data space or two-partition layout.)

- Provides save-set marks to enhance segmentation.

- Allows filemarks and save-set marks without decreased capacity.

- Supports third level of ECC (C3) for optimal data reliability.

- Provides redundantly-stored, track-based checksums for increased data reliability.

- Provides Read-After-Write (RAW) and frame repetition on error.

- Provides randomizer for increased data reliability.

- Provides N-Group writing for tape duplication applications.

- Supports fast search to data, marks, and EOD.

- Does not require formatting.

- Supports short tape load sequences.

- Provides areas for Tape Error Logs.

DDS-DC Format

The advantages of the DDS format are retained in the DDS-DC format, which is an extension of the DDS format that supports data compression. In addition to the previously listed benefits of data compression in increasing storage capacity at fast transfer rates, the DDS-DC format provides these capabilities:

- Maintains high performance by the compression algorithm while avoiding controller-induced limitations of the transfer rate when handling multiple, small fixed-length records.

● Allows writing of compressed and uncompressed records to the same cartridge.

In the DDS-DC format, a data record is the smallest data object. A record is typically the smallest distinct set of data bytes transferred between a host and a tape drive. The DDS-DC format supports compressed and uncompressed records (or Processed and Unprocessed records) with the compressed records recorded into objects called **entities**.

DDS-DC groups can be made up of entities and uncompressed records. Each group contains an index that describes the contents of the group.

Commonalities Between the DDS and DDS-DC Formats

Because the DDS-DC format is an extension or superset of the DDS format, many commonalities exist between the two formats. These commonalities are outlined in the following points:

● The series of transformations (randomizing, interleaving, generating and including two Reed-Solomon error-correction codes, blocking and translating bytes to channel bits) applied to each group

● The definition and use of the third, group-based Reed-Solomon error-correction code

● The method of recording a group

● The tape layout (partitioning, Device Area, System Area, Data Area, and EOD Area)

● The rules for recording multiple occurrences of a group in contiguous sequence

Basically, the only differences between the two formats are in the contents of groups.

This chapter describes the DDS and DDS-DC formats. The information is divided into six major topics:

● Entities (DDS-DC format only)

● Tape Layout

● Data Storage Organization

● Indexing

● Vendor Group

● Read-After-Write

Information describing the DDS-DC extensions to the DDS format are tagged as DDS-DC only.

Entities (DDS-DC Format Only)

An entity is a recorded object that consists of an entity header followed by one or more compressed records. The compressed records in an entity must be based on uncompressed records of equal size. All of the compressed records in an entity depend on the same access point for decompression. An **access point** is the 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. Thus, the access point may or may not exist at the start of the first compressed record in the entity; however, access points cannot appear elsewhere in an entity.

Access points are required in certain cases and are important when performing SCSI **SEEK** or **LOCATE** commands to a record within a entity. The first entity in a group must have an access point. Also, an access point is required at the beginning of the first compressed record of an entity following a filemark, a setmark, or an uncompressed record.

As long as all of the entity header and the first 8 bits of the first compressed record in the entity are in the same group, an entity may cross groups. However, the requirement that an access point occur at the first entity in a group means that all span points must occur within the last compressed record of an entity.

The entity header is made up of 8 uncompressed bytes as outlined in the following points:

● Byte 1 contains the length of the entity header (08h)

● Byte 2 is reserved

● Byte 3 specifies the compression algorithm identifier number (when an access point occurs at the beginning of the entity) or specifies that the compressed records in the entity depend on a the access point in the previous entity (all bits zero).

● Bytes 4 to 6 reflect the length of the uncompressed record or records from which the compressed record or records in the entity are derived. (If the entity contains more than one compressed record, they must all be based on uncompressed records of equal length.)

● Bytes 7 to 8 show the number of compressed records in the entity.

Tape Layout

The DDS and DDS-DC formats support two tape layouts: a single data space (one partition) and two-partitions. The data organization is the same for either tape layout -- a sequence of groups with each group having a fixed capacity.

The single data space provides a capability similar to 1/2-inch reel-to-reel tape. It allows for sequential storage and access to data and separator marks in a continuous space, which spans the entire tape volume.

The two-partition layout gives the same capability in each of two independent partitions on the tape. Data may be written to either partition without affecting the other partition; thus, data could be written alternately between partitions.

Single Data Space Layout

The single data space tape layout uses the entire tape volume to sequentially store data and to access the data and separator marks. This layout is made up of four areas:

- The Device Area

- The Reference and System Area

- The Data Area

- The End-of-Data (EOD) Area

Figure 6-1 shows this tape layout.

Figure 6-1
Single Data Space Tape Layout
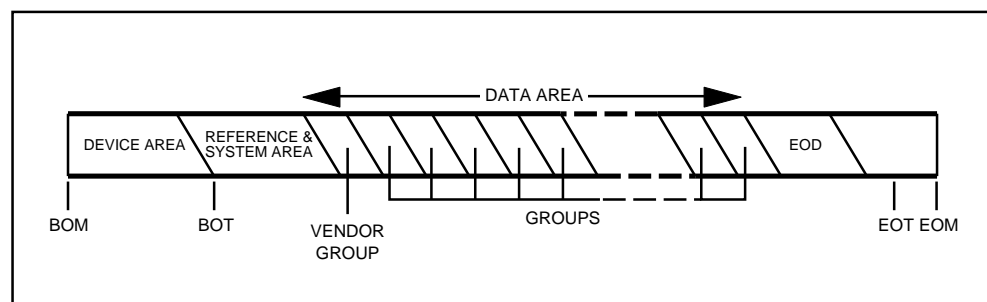
Device Area

The initial section of the tape is the Device Area, which is used to load the tape and is NOT used to write any user data.

Some slight indentations to the tape may result from the clamp that holds the tape to the hub. These indentations are generally more pronounced at the

beginning of the tape. Therefore, this section acts as a safeguard against writing data over these indentations.

Once a sufficient distance from the Beginning-of-Media (BOM) is attained, a device area is provided. This area consists of three zones: a spin-up zone, a test zone, and a guard zone.

The first zone, the spin-up zone, is wrapped around the drum when the tape is loaded into the drive. The contents of the spin-up and test zones are not specified in the format standards.

The guard zone immediately follows the test zone and contains no valid signals recorded on it. This zone is a guard zone between the test area and the start of recorded frames.

Reference and System Area

The second area on this tape layout is the Reference and System area, which provides logs of usage and soft error occurrences. The System area allows such logs to be updated by being overwritten in the same physical location. The Reference area defines the Beginning-of-Tape (BOT) point and allows efficient positioning during an update. The reference area is recorded only by the first drive to record on a blank cartridge.

Figure 6-2 shows the layout of the Reference and System area.

Figure 6-2
Reference and System Area Layout
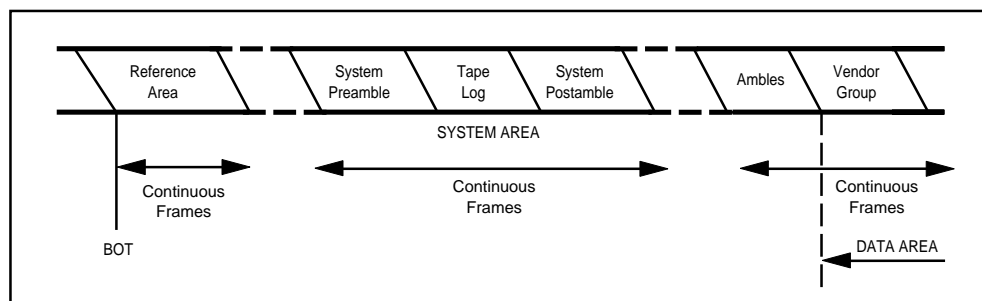
Reference Area

The Reference area is the first collection of frames written on the tape after the BOT. It is a reference point when determining the tape format and updating the System area. This area consists of 35 frames followed by a band of between zero and ten frames. Because updating the System area may result in a physical position of the new System area that is not identical to its previous physical position, this band allows a sufficient tolerance to allow for variation. The Main Data area of all tracks in the Reference are set to zero.

System Area

The System area consists of:

- The **System Preamble**, which allows the servo to synchronize before reading the System Log.

- The **System Log**, which contains tape usage information, including current usage error count. The System Log in this format contains information for the entire tape.

- The System Postamble, which consists of ten frames. Immediately following these frames is another band of ten identical frames. These extra frames allow a position tolerance for updating the System area.

During the cartridge ejection sequence, the System area is updated. Because of this updating, the physical length of the System area must remain constant.

Frame rewriting is not used on any frames in the System area. This factor could cause the Main Data area to be incorrect; thus, the Main Data area is not used and is set to zero.

Because the Sub areas are repeated many times, the Sub area is used to store the usage information.

The frames following the System area allow the servo to resynchronize before it must read the Vendor Group.

Data Area

The third area on this tape layout is the Data area, which is written as a sequence of groups beginning with a special Vendor Group. Each group is a fixed size and stores uncompressed records, entities (DDS-DC format only), filemarks, and save-set marks written by the host. The variable-length records and filemarks are mapped into the group by indexing.

End-of-Data (EOD) Area

The last area in this tape layout is the End-of-Data (EOD) area -- the point on the tape where the host ceased writing data. This area is not specifically written through host command. Rather, the drive will detect any conditions -- such as a **REWIND** following a **WRITE** command -- which comprise EOD and then generate the EOD area. The area is physically long enough to guarantee that it is detected during fast searching. A set of at least 12 Data area preamble frames, continuous and contiguous with the last frame of the last data group written, precedes the EOD area.

In the case where existing data is partially overwritten and the overwrite ends before the existing EOD area, a new EOD is generated at that point. A tape may, therefore, contain more than one EOD area. However, the EOD closest to the BOT is the only valid one. Any data or other EOD areas beyond that point are logically inaccessible.

Two-Partition Layout

The two-partition tape layout provides two separate areas that may be written independently to be contained on a single tape volume. The host chooses the tape layout—single data space or two-partition—before it sends data for writing to a blank tape for the first time or when it sends a tape format command.

The two partitions are adjacent on the tape with no gap between them. The partition closer to the BOM is Partition 1; the partition closer to the EOM is Partition 0. The boundary between the partitions is defined by an upper limit of the value of the Absolute Frame Count of Partition 1.

The two-partition layout is generally made up of:

● The Device Area

● Partition 1

● Partition 0

The Device area is the same as the Device area for the single data space tape layout. Also, each partition is made up of a Reference and System area, a Data area, and an EOD area. These areas are the same as for the single data space tape layout. Additionally, Partition 1 contains a synthetic EOT and EOM; Partition 0 contains a synthetic BOT. Thus, each partition is structured identically to a single data space tape except for the Device area.

Figure 6-3 illustrates the two-partition tape layout.

Figure 6-3
Two-Partition Tape Layout
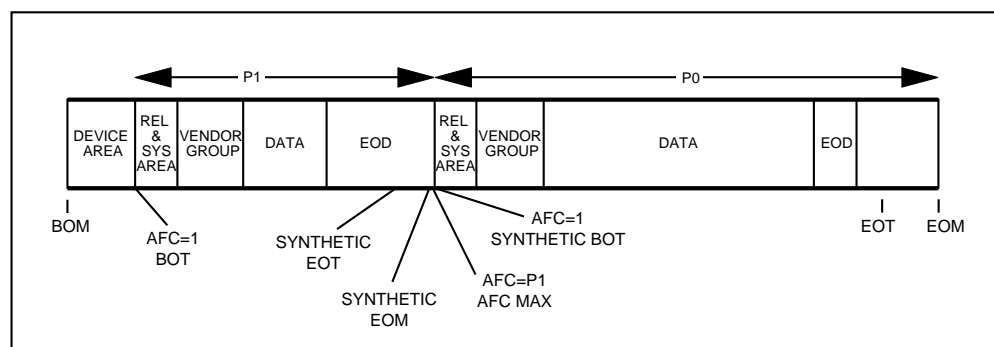
Data Storage Organization

The data storage organization of the DDS and DDS-DC formats is based on two considerations:

- Individual track layout

- Data groups

Like the audio format, the DDS and DDS-DC formats allocate 60 percent of each track to user data and ECC. The remaining 40 percent is divided between automatic-track-finding (ATF) signals and the subcode area. The ATF and subcode areas are collectively called subareas and are used to maintain information about the location of data records, filemarks, and save set marks.

The data area on the tape is organized into **groups**. Each group is made up of a fixed number of frames and has a fixed capacity. A group stores host written data, save-set marks, and filemarks. In the DDS format, the host written data consists of uncompressed records; in the DDS-DC format, the host written information may consist of uncompressed records and entities.

Although a group has a fixed size in memory, each group does not necessarily contain the same number of physical frames. Some frames may be rewritten because an error is detected by the Read-After-Write process.

If a host record is larger than the space remaining in the group, the space is filled, and bytes not accommodated are placed in the next group.

In the case where a group is not fully occupied by user data, the group is still written as the fixed logical size, but the index reflects its actual contents.

Individual Track Layout

The layout of an individual track is made up of a main area and two subareas, as shown in Figure 6-4.

Figure 6-4
Individual Track Layout and Group for DDS and DDS-2
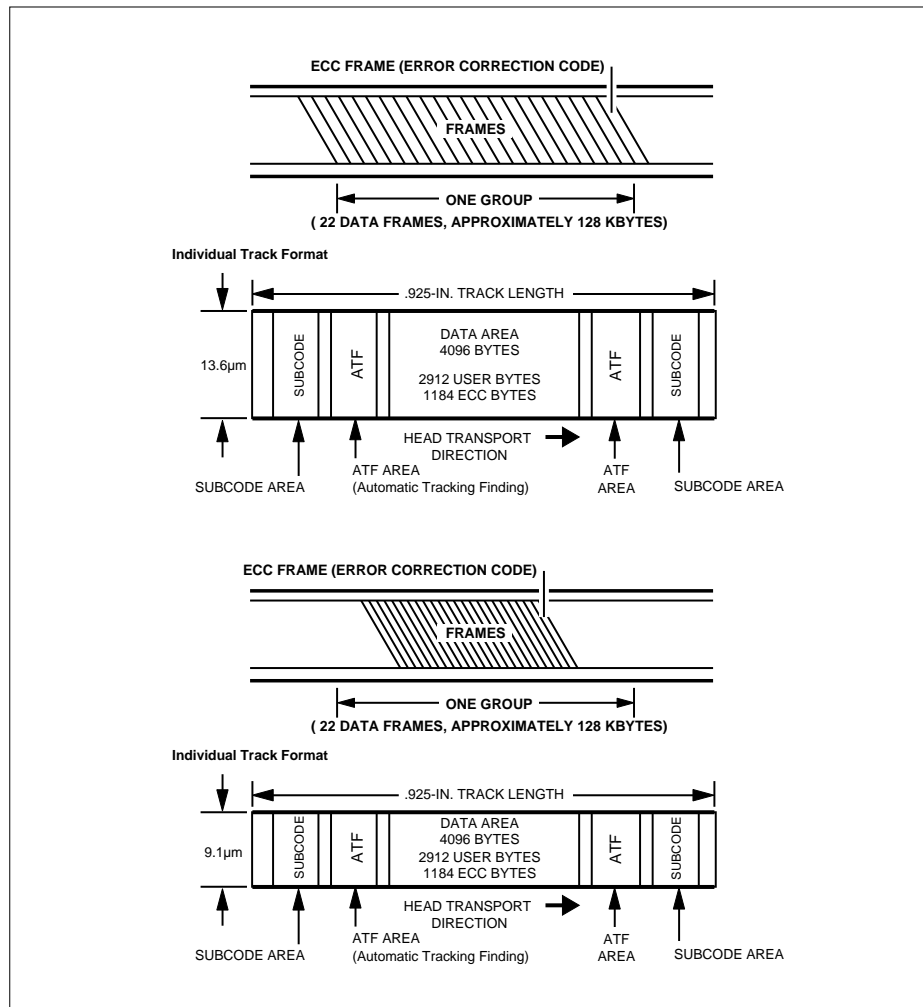
Main Area

Within the individual track, the main area is made up of the 128 main data blocks. Each main data block is made up of the following:

- Synchronization (8 bits)

- Main ID (16 bits -- W1 and W2)

- Main ID parity (8 bits)

- Main data (256 bits)

Synchronization Pattern: The 10-channel bit synchronization pattern corresponds to 8 bits, which are contained in the synchronization portion of the main data block.

Main ID: The Main ID is made up of W1 (8 bits) and W2 (8 bits). These bits identify various characteristics about the main data area.

The **Block Address** is determined by W2, bit 7, which identifies the type of block. The remaining seven bits of W2 -- B6 (msb) through B0 (lsb) -- are the identify bits for the main data block address (0 to 127) in one track.

The **Frame Address** is a 4-bit code of W1 -- B3 (msb) through B0 (lsb) -- in even address blocks. The frame address repeats from 0000 to 1111.

The Format ID is a 2-bit code of W1 -- B7 and B8 -- which shows the application of the main ID and main data where:

> 00 = audio format
> 01 = DDS or DDS-DC format

Main ID Parity: The Main ID parity bits provide the error detection mode for W1 and W2.

Main Data: the main data block contains 32 symbols (each 8-bits long) of data. Each symbol is assigned a number 0 to 31 along the recording direction.

The two kinds of symbols are:

- Data

- Parity

The three kinds of blocks are:

- Data only

- Data and parity

- Parity only

Main data in one track may store 2912 symbols of data, 672 symbols of C2 parity, and 512 symbols of C1 parity.

The main data area is made up of:

- The header (first four bytes), which contains format information

- 5756 bytes of user data

- 64 bytes of zeros

The header contains the **Data Format ID (DFID)** for the tape with 0000 indicating the DDS format.

The **Logical Frame ID (LF-ID)** contains the logical frame number (bits 8-13), the ECC frame ID (bit 14), and the last frame ID (bit 15). If bit 14, the ECC frame ID, is 1, the current frame is the ECC frame of the group.

A **data word** is made up of 16 bits which comprise two data symbols. The data word can be for channel A or B.

Subareas

The two subareas per track each contain a sub data area of 8 blocks. Each block contains a sub ID and sub data. The sub data is made up of four packs or three packs and C1 parity.

In any one subarea, the mix of pack items varies between different areas of the tape.

Within one sub ID for a block of the sub data area, the *area ID* identifies the current area on tape and the type of current frame, where:

> 0000 = Device area
> X001 = Reference area
> X010 = System area
> X100 = Data area
> X101 = EOD area
> others are reserved
>
> Above, X is 0 for Partition 1 and 1 for Partition 0 in a two-partition tape. For a single data space tape, X is 1.

The various pack items represent different types of information such as, group count, filemark count, save-set count, the absolute frame count, checksums, N-group reading counts, and ECC retries.

Group Structure

A group is made up of 22 data frames for a size of 126632 bytes and an optional ECC frame. Groups are separated by zero or more amble frames. The 22 data frames contain host written data and index information. Figure 6-5 shows the group structure.

Figure 6-5
Group Structure

ECC FRAME (ERROR CORRECTION CODE)

FRAMES

ONE GROUP
(22 DATA FRAMES, APPROXIMATELY 128 KBYTES)
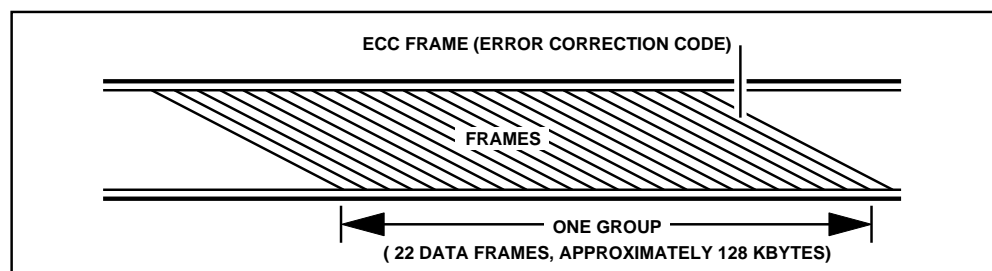
Figure 6-6 compares a group in the DDS format without compression to a group in the DDS-DC format with compression. As an example, a 3.2:1 compression ratio is depicted. The size and structure of the groups are the same. However, the contents of the group are different in that the group in the DDS-DC format may contain uncompressed records and entities.

Figure 6-6
Group Structure---DDS and DDS-DC Formats
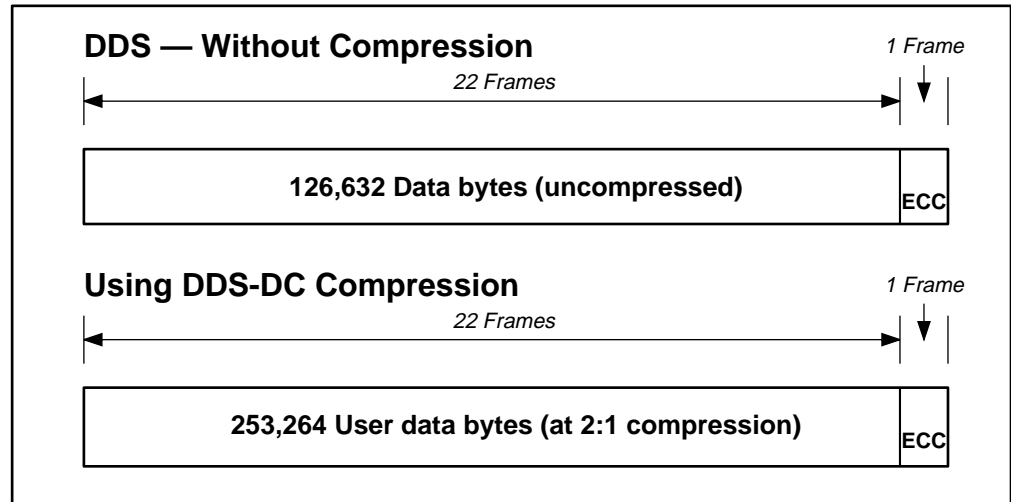
Data Frames

Each group can store 22 frames of data for a size of 126632 bytes. It may consist of more than 22 frames if any are rewritten using the Read-After-Write process.

Index

The index is stored as part of the group. its size grows as needed to describe the group contents. The index is stored at the end of the group and grows toward the front of the group. A Group Information Table (GIT) occupies bytes 126601 through 126632. A Block Access Table (BAT) is located immediately before the GIT. The first 4-byte entry of the BAT occupies bytes 126597 through 12660 with additional BAT entries extending toward the front of the group.

If necessary, records are split as needed to fill a group complete with data and index information.

A group that is not filled with user data contains an index specifying that it is not full. However, that group must still contain 126632 bytes.

Refer to **Indexing** later in this chapter for more information about the GIT and BAT.

ECC Frame

The 22 data frames are followed by an ECC frame that contains the third level of error correction (C3). The first two levels of error correction (C1 and C2) are embedded in the frame itself and are identical to those used in the audio format. These levels of ECC only cover the data within a frame. C1 and C2 can correct an error in each track up to 792 bytes long.

The third level of ECC provides recovery across frames. Only the frames in the group are covered by the third level of ECC. Each group is considered independently of all other groups. The Main Data area of the ECC frame contains the actual error correction bits.

The third level of ECC can correct any two tracks that are bad in a group. These tracks may be of the same or different azimuth angles and may be in the same or different frames.

Amble Frames

Amble frames are only written after the last frame in a group or after another amble frame. The amble frame contains a valid Header, but the remainder of the Main Data area is set to zero. The logical frame number of an amble frame is zero.

Indexing

The indexing concept allows variable-sized host records to map onto fixed-size groups. All groups except the Vendor Group contain an index. Each index is divided into two parts:

● The Block Access Table (BAT), which describes the contents of the group and has an entry for each record and save-set mark.

● The Group Information Table (GIT), which contains a list of counters and pointers that describe the characteristics of the group. For the DDS-DC format, the definitions of three of the fields in the GIT are extended.

Group Information Table (GIT)

The GIT is included in each group. It is in a fixed location at the end of the group and is the same size regardless of the contents of the group (bytes 126601 through 126632). It contains a list of counters and pointers that describe the characteristics of the group. Its entries are two or four bytes wide.

For the DDS-DC format, the Record Count, Number of Records in Group, and Previous Record Group Count fields are extended as described in the following text.

Group Count: The Group count is the number of user data groups written since the beginning of the current partition, beginning with one and including the current group.

Block Access Table Count: The Block Access Table Count is the number of entries in the Block Access Table.

Record Count: The Record Count is the number of records written since the BOT of the current partition and includes any completed records in the group.

For the DDS-DC format, this 4-byte field specifies the sum of the values in the Number of Records in Group of the GIT of all groups written after the logical beginning of tape (LBOT) through the current group.

▶ **Note:** As in the DDS format, bytes 4 through 7 of Pack item 2 (sub data) in the DDS-DC format is the same as the Record Count fields in the GIT. The DDS-DC extension for this field also applies to Pack Item 2.

Filemark Count: The Filemark Count is the number of filemarks written since the BOT of the current partition.

Save-Set Count: The Save-Set Count is the number of setmarks written since the beginning of the current partition up to, and including, the current group.

Number of Records in Group: The Number of Records in Group is exactly the number of entries in the Block Access Table of the current group with the Record End bit set.

For the DDS-DC format, this 2-byte field specifies the sum of the following:

● The number of mark entries in the BAT of the current group

● The number of Total Count of Uncompressed Record entries in the BAT of the current group

● The number of Entire Uncompressed Record entries in the BAT of the current group

● The sum of the numbers of compressed records within all entities for which the BAT of the current group contains Entire Entity entries

● The number minus one of compressed records in the entity for which the BAT of the current group contains a Start Part of Entity entry, if an entry exists

● The number of Total Count of Entity entries contained in the BAT of the current group

Previous Record Group Count: The Previous Record Group Count is the number of the group containing the most recent beginning of record.

For the DDS-DC format, this 2-byte field specifies the running number of the highest-numbered previous group that contains the beginning of an

uncompressed record, an access point, a filemark, or a setmark. If no such group exists, it contains zero.

Number of FMs in Group: the Number of Filemarks in Group is the total number of filemarks written in the current group.

Previous FM Group Count: the Previous Filemark Group Count is the number of the group containing the previous filemark written on the tape in the current partition or is zero if no such group exists.

Block Access Table (BAT)

The BAT identifies the contents of the group. It contains an entry for each uncompressed record, filemark, and save-set mark. For the DDS-DC format, it additionally contains an entry for each entity in the group. If the group contains partial uncompressed records, each of those also has an entry in this table. In the DDS-DC format, if the group contains a partial entity, each of those also has an entry in this table.

The size of the table depends on the contents of the group. Access entry for the first item in the group is located immediately before the Physical Information. The other access entries follow in a reverse direction in the order of the contents of the group.

The entries in the BAT are each a 4-byte field that contains a flag byte (byte 1) and a count field (bytes 2 through 4), which contains a number based on the flag byte. In the DDS-DC format, all BAT entries for entities and uncompressed records are defined and used the same as in the DDS format except for bit 5 of the flag byte. The following table lists the bit configurations for the flag bytes relating to entities (DDS-DC format only).

Bit Configuration	*Description*
0111X011	The entity starts in the current group and ends in a subsequent group (Entire Entity). The count field specifies how many bytes the entity contains.
0101X010	The entity starts in the current group and ends in a subsequent group (Start Part of Entity). The count field specifies how many bytes are contained in the part of the entity that is in the current group.
0101X000	The entity starts in a previous group and ends in a subsequent group (Middle Part of Entity). The count field specifies how many bytes are contained in the part of the entity that is in the current group.
0111X000	The entity starts in a previous group and ends in the current group (Last Part of Entity). The count field specifies how many byte are contained in the part of the entity that is in the current group. An entry for the Total Count of Entity must follow this entry in the BAT of the current group.
0001X001	This entry (Total Count of Entity) follows an entry for the Last Part of Entity in the BAT. The count field specifies the total number of bytes in the entity.
Note:	All other bit configurations for the flag byte relate to uncompressed records and are identical to those defined in the DDS format.

Vendor Group

The Vendor Group is the first group in a partition. It is preceded by an amble area. The Vendor Group is not accessible via the SCSI bus.

This group contains user data area fields, which are briefly described in the following paragraphs.

The only required fields are ASCII strings that give the name of the manufacturer and the model number of the drive.

Name of Manufacturer (Bytes 0 -127): The name of the manufacturer of the drive that initialized or wrote the partition is required. This field is an ASCII string (null terminated and padded).

Model Number (Bytes 1287-159): The model number or identifier of the drive that initialized or wrote the partition is required. This field is an ASCII string (null terminated and padded).

Host Interface Type and Address (Bytes 224-255): The type of host interface and its connection may appear here. (Bytes 224-239 = type; bytes 240-255 = address). This field is an ASCII string (null terminated and padded).

Bytes 400 - 5755 are reserved and are set to ASCII null character.

Vendor Unique (Bytes 5756-126631): Contents not specified.

Read-After-Write

The Read-After-Write (RAW) technique provides a means of verifying that host data was written on the tape correctly by reading it later. After each frame is written, it is examined to determine whether or not it is correctly recorded.

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. The maximum number of times a rewrite sequence can occur is 128 (original plus 127 repeats).

Media Recognition System (MRS)

The Media Recognition System (MRS) refers to a series of alternate opaque and clear stropes at the beginning of a tape. This striping is used to classify the media as data grade, rather than audio grade media. All 120-meter cartridges have MRS. Shorter media are available in both MRS and non-MRS types.

Data Compression (4000 and 8000 Series Only)   7

Introduction

Typical data streams of text, graphics, code, or other forms of data contain repeated information that is considered redundant. This redundancy occurs because the data contains groups of symbols that are repeated or exhibit a particular pattern. Storage efficiency is increased if the redundance in the data is removed before the data is recorded to tape. Simply repeating the same information on tape wastes valuable and limited space.

With data compression, the redundant (repeated) information in a data stream is identified and then represented by codewords or symbols, which allow the data to be recorded in a fewer number of bits. These symbols or codewords encode the redundant strings or point back to the original string, thus 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 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 considerations:

- The amount of compression (measured by the *compression ratio*, which is a ratio comparing 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 integrity of the compressed 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. (Uncompressed data is compressed and then decompressed without error---*lossless* compression.)

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

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

Because various types of data are encountered for compression, the data compression method must be able to *adapt* to different types---automatically providing optimum handling for all types of data. If only one type of data is to be compressed, an effective data compression method can be tailored to achieve maximum speed and storage for that type.

However, an effective data compression method for a tape drive must serve varying data types while ensuring maximum storage and transfer rates as well as maintaining data integrity. Thus, creating an effective data compression method with those stipulations requires integrating several design decisions that work together.

In these drives, these design decisions centered on the following:

● Supporting the DDS-DC format (See chapter 6 for more information.)

● Implementing the Data Compression LempelZiv (DCLZ) algorithm, which is based on the LZ2/LZW algorithms

● Using the Seagate SCSI/data compression chip for hardware compression in the drive

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** (LempelZivWelch) 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 look 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. Thus, 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.

These drives use the DCLZ algorithm, which is based on the LZ2/LZW type of algorithm. A more detailed description of the algorithm is given later in this chapter.

Hardware Compression

Because the DCLZ algorithm is implemented in the SCSI/data compression chip in the drive itself, the compression is transparent to the host computer and the user.

If data compression is implemented in software on the host computer rather than in the hardware of the drive, the transfer rate of the host can be retarded because the host 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 resident.

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

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

Data Integrity

Generally, errors do not occur within the electronics of a tape drive. When errors do ocur, the majority of these errors occur in reading or writing data to or from media where physical motion is involved and where environmental conditions are factors.

With hardware data compression in the drive, the data compression takes place within the drive electronically, which reduces the physical motion and thus further reduces the possibility of errors. For example, if the error rate without data compression is 1 in 10^{15} and a compression ratio of 4:1 is achieved, then the data compression error rate becomes 1 in 4×10^{15}. This decrease in error rate becomes a multiple of the compression ratio. However, because more data is recorded on a given physical space with data compression, more data is lost than without data compression if an error occurs in that space.

The DCLZ algorithm is itself a lossless algorithm, which ensures that the compressed data can be decompressed without error. Of course, if an error is present in the uncompressed data, that error is still present in the compressed, and then decompressed, data.

DCLZ Algorithm

The DCLZ algorithm used in the 4000 and 8000 series drives 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. The DDS Manufacturers Group and QIC tape industry standards committees accept DCLZ as an approved standard.

The DCLZ algorithm removes redundant information in a data stream by recognizing and encoding patterns of input characters. When a unique string of characters is encountered, that string is entered into a dictionary and assigned a numeric value. After a dictionary entry is created, when that string (the dictionary entry) is again encountered, it is replaced in the data stream by its numeric value (codeword).

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 does have 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.

Input Byte	Current String	Match	Build Entry	Output Code Value
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 in order to recreate the original data exactly.

The dictionary allows up to 4096 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 4095.

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 4095:** 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
steam is processed. These codes are pointers to other locations and
eventually end by pointing to one of the byte values 0 through 255. Thus, 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 physically 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 20-22** are condition flag bits.

Dictionary codewords range from 9 through 12 bits in length and correspond to
dictionary entries from 0 through 4095. These entries are divided as follows:

- First 512 entries are 9-bit codewords.

- Second 512 entries are 10-bit codewords.

- Next 1024 entries are 11-bit codewords.

- Final 2048 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 such 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. (Thus, 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.

Input Code Value	Byte Value	Pointer	Root ?	LIFO	Entry	Output Byte
(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 previous two tables.

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

SCSI/Data Compression Chip

The Seagate SCSI/data compression chip used in the 4000 and 8000 series drives provides the basis for an effective data compression system using the DCLZ algorithm. Using this chip implements hardware data compression in the drive itself. This device includes a SCSI controller and a data compression processor arranged in an in-line 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 MB/sec maximum throughput for synchronous operation and 7.0 MB/sec for asynchronous operation

- Compatible with DDS compression standards

- Supports 16-bit DMA transfers

- Provides internal data FIFO

- Supports data pass-through mode to bypass compression

- Provides internal SCSI data FIFO

- Built-in DMA control unit

Overview

The device contains compression and decompression circuitry, which forms the core of the data compression system by implementing the DCLZ algorithm. This core is called the **DCLZ machine**.

Data from the SCSI bus is compressed by the DCLZ machine 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. The Microprocessor/DMA interface is configured for 16-bit data transfers. However, that interface performs byte operations in the event of an odd block size.

Figure 7-1 illustrates the layout of the SCSI/data compression device.

Figure 7-1
Layout of SCSI/Data Compression Device

NOTES

Theory of Operations 8
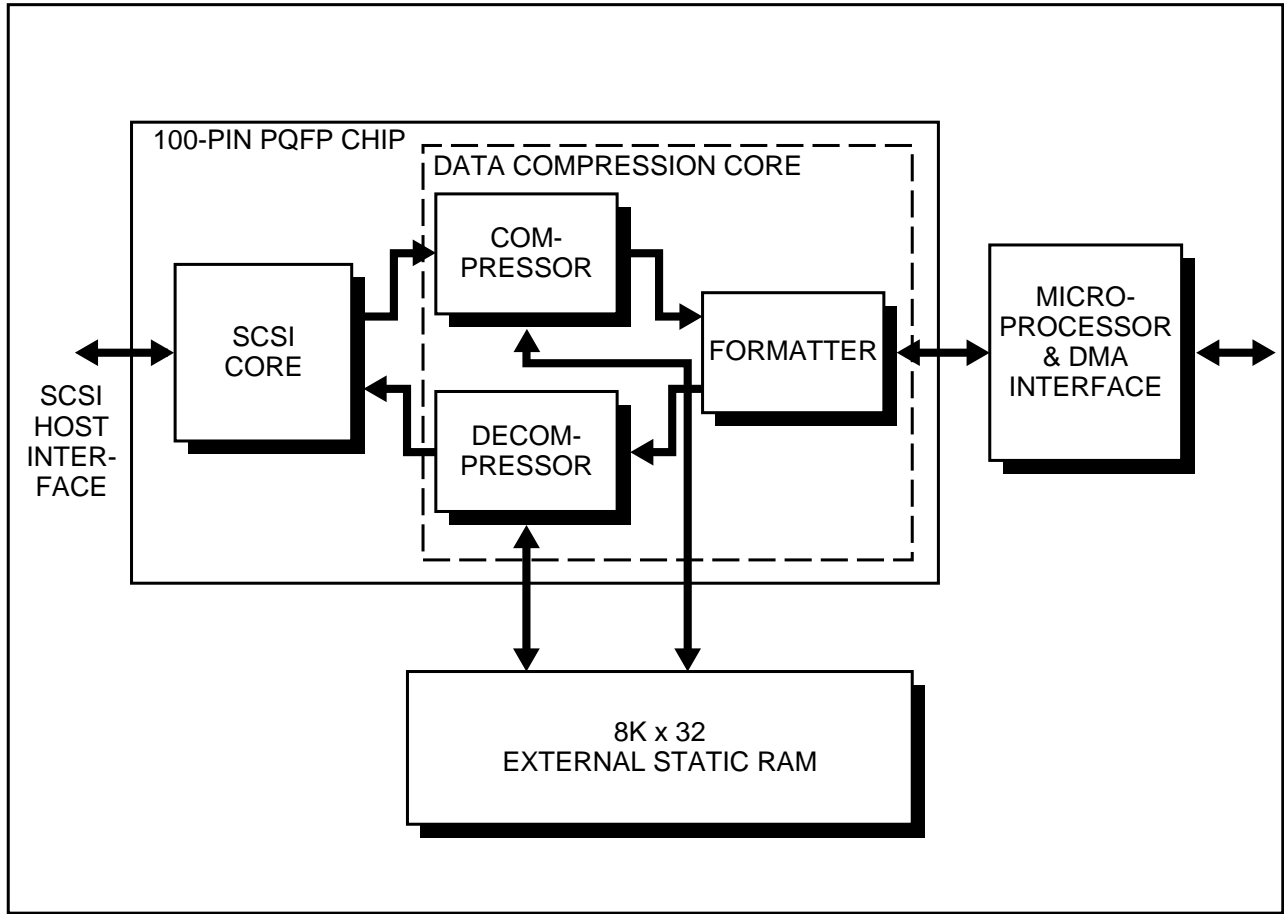
Overview

The design of these drives integrates the 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 utilized 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 using complementary metal-oxide semiconductor (CMOS) technology.

- Implementing the DDS and DDS-2 formats.

- 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 DAT drive in more detail and explains implementation specific information.

Block Diagrams

The electronics of these DAT drives are laid out on one main printed circuit board (PCB).

STD18000N Drives

This section generally describes the hardware design features of the drives. You may want to refer to the block diagrams referenced previously as you read this information.

These computer DAT drives use the helical scan recording method employing a four-head design. Four direct-drive motors and one brush-type motor are used in the drive. Also, the read and write functions are implemented using 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.

Additionally, the mechanism is designed for minimum tape wear and prevention of damage to the tape. The modes or operational states, such as stop, rewind, play, etc., are specifically implemented to 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. Figure 8-3 shows the operational modes in relation to mode changes. All mode selection is performed by the controller firmware. The host computer does not directly control mode selection.
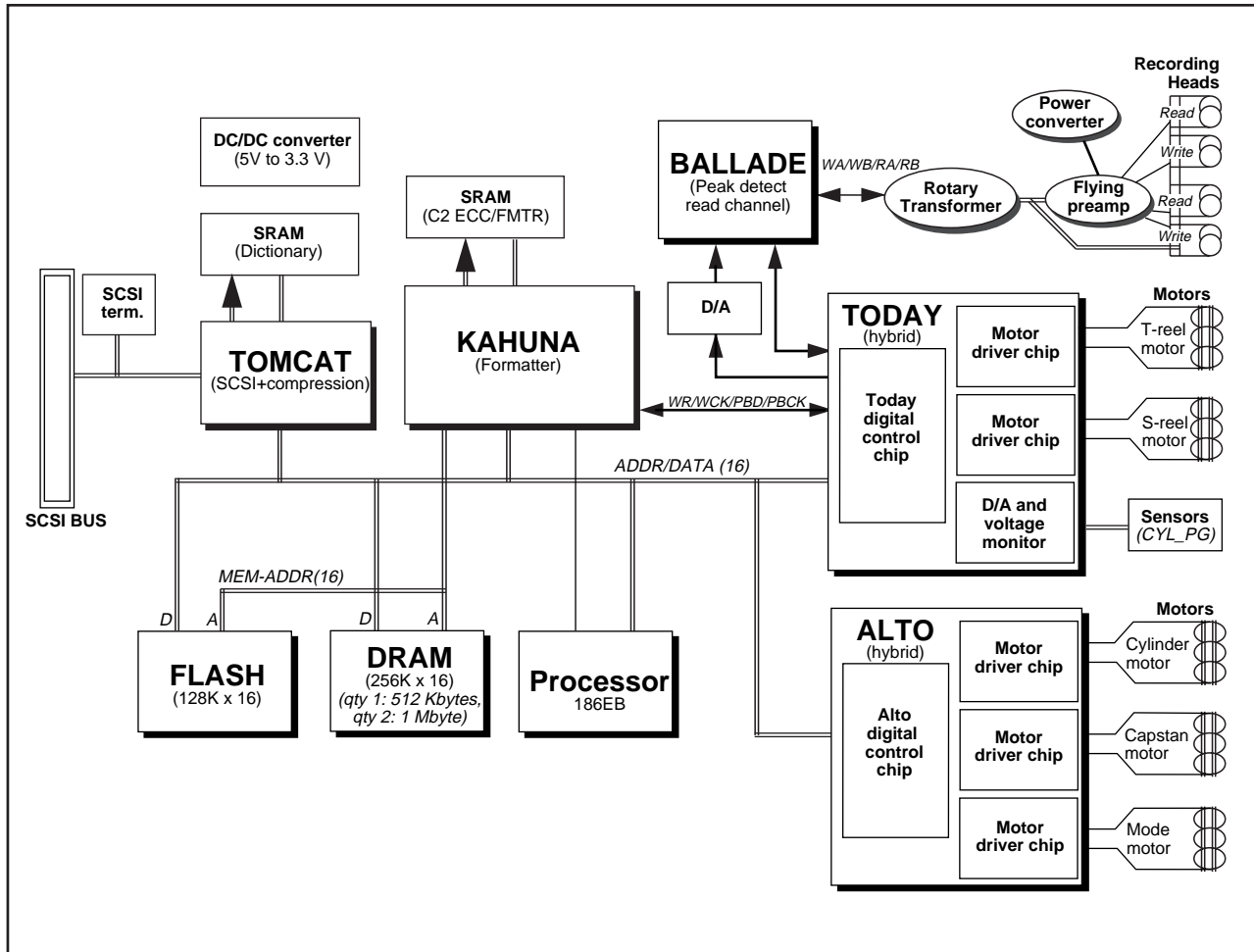
Figure 8-1
Simplified Block Diagram—DAT Drives

Figure 8-2
Block Diagram—SCSI Controller DAT Models
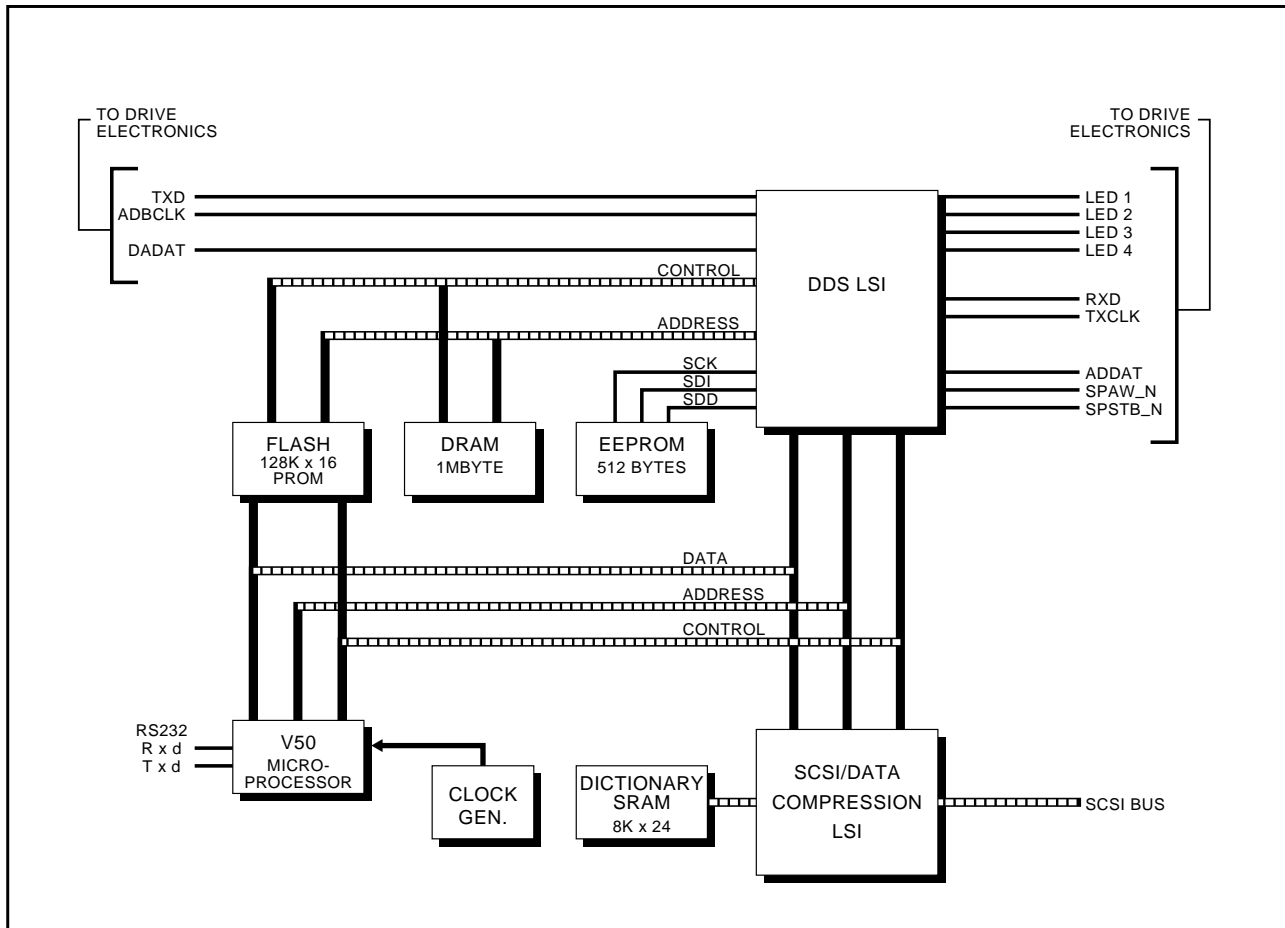
Figure 8-3
State Diagram
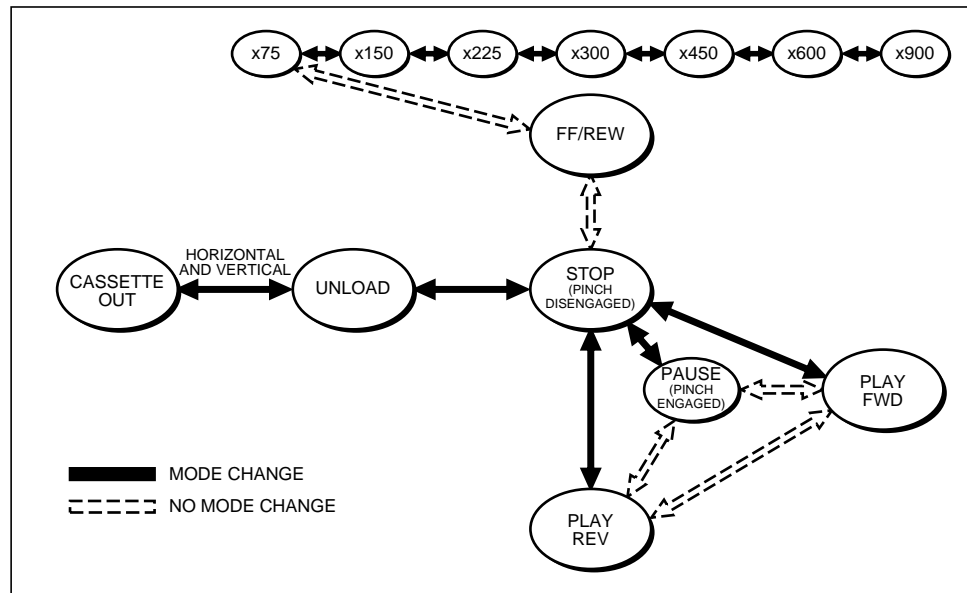
A custom timing tracking design combined with the four-head design implements the ANSI DDS standard specifications and provides the precision required to perform **seamless appends**, the ability to add information after a stop immediately adjacent to the last data written on the tape, with no significant loss of tape storage capacity.

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

Using the jumpers, you can 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:** Also, a terminator power fuse provides protection from component damage in case the SCSI cable is connected upside down (with terminator power enabled).

The drive provides several sensors, both optical and mechanical, to conform to the ANSI Helical Scan Tape Cartridge specification; to effectively implement mode changes; and to insert and eject the cartridge.

Two rectangular front panel light-emitting-diodes (LEDs) indicate 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.

These topics are discussed in more detail in the following sections.

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 6000 revolutions per minute (rpm). At the same time, the tape moves slowly (0.64 inch/second in DDS-2 mode and 0.96 inch/sec in DDS 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 drive is designed with four, long-life ferrite heads -- two read and two write heads. These heads are set opposite one another on the cylinder 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 can be performed immediately after the data is written.

The cylinder rotates rapidly (6000 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 plus 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 372 ips.

Figure 8-4 illustrates a helix track, the four-head design, and shows the 102 degree wrap angle.

Figure 8-4
Four-Head Design
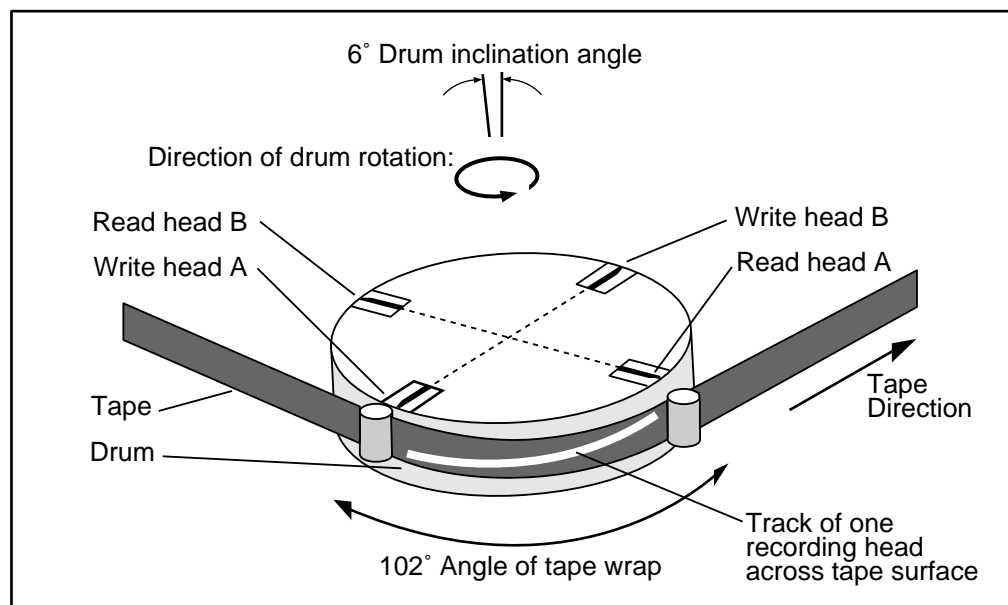
The recorded tracks are written diagonally across the tape from bottom to top by each write head. Because the head is wider than the track written, tracks overlap with no tape space between them. In conventional recording, such

overlap or even "close proximity" would result 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 8-5.) 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. Thus, 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 8-5 shows alternate tracks and alternate azimuth angles.

***Figure 8*-5**
Alternate Azimuth Angles
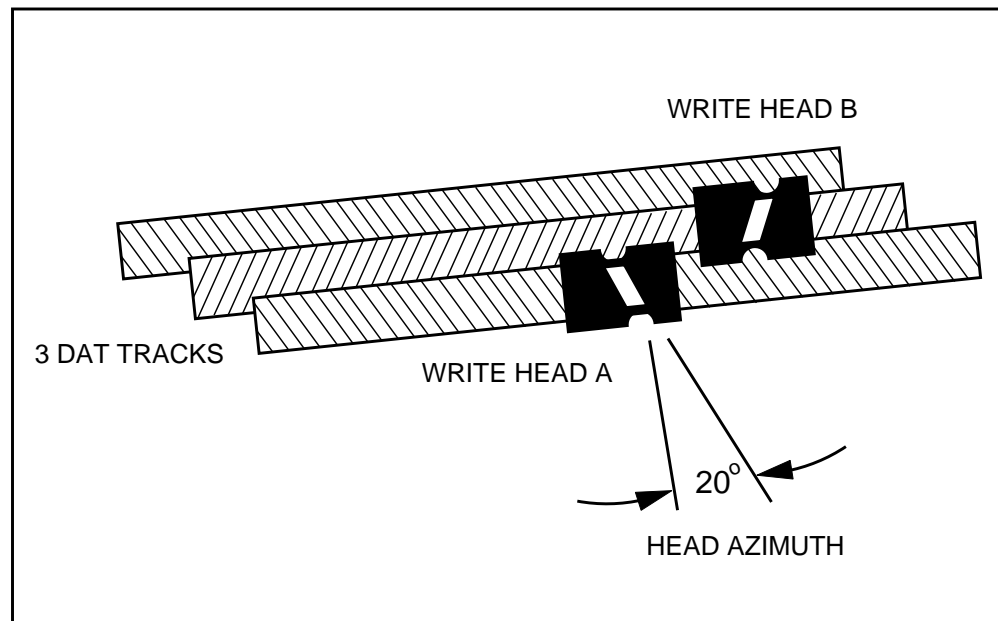
When the 8000 series drive recognizes a 120 meter MP+ cartridge, it automatically reads and writes the DDS-2 format which has a track density 1.5 times greater than conventional media. The track pitch for the DDS-2 format is 9.1 um instead of the conventional 13.6 um. If the tape cartridge contains MP tape, the drive automatically switches to DDS mode.

Motors and Control Circuits

The DAT products use 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 and loads and ejects the cartridge. The two reel motors turn the tape reels.

Cylinder Servo is controlled by the microprocessor. The Microprocessor also controls the Cylinder and Capstan Drivers as well as the Supply-Reel and Takeup-Reel motors.

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.

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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 tracking tracking circuitry of the drive is designed to provide high precision tracking and head positioning in compliance with the ANSI DDS standard. The timing tracking, in conjunction with the four-head read-after-write (RAW) design, allows **seamless appends**, also in compliance with the ANSI DDS standard.

A seamless append is the continuation of writing frames on the end-of-media (EOM) side of existing frames (after a STOP) such that the tracks are placed as if they were in a continuous sequence. That is, the servo system must be able to read the appended tracks without encountering discontinuity or gaps between tracks.

Performing a seamless append requires the highest precision and almost absolute accuracy in repositioning the head assembly. In the DAT products, this level of precision is attained through the combined accuracy of the mechanical design and the ATF signal information as implemented through custom circuits.

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 1 MB.

The SCSI/data compression chip, which is a 100-pin PQFP provides the SCSI core as well as 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 DAT drives use flash memory, the drive firmware can be easily upgraded when new revisions of the firmware are released. The SCSI controller circuitry includes 256 KB of flash memory on these models.

Loading new firmware can be accomplished in one of three ways:

- Using a specially encoded firmware upgrade cartridge.

- Issuing a **WRITE DATA BUFFER** SCSI command to download the firmware to the EEPROM.

- Drive serial port.

Refer to chapter 4 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 to determine the position of the loading mechanism. The other mechanical sensors determine specific information based on detecting the open or closed state of four recognition holes in the DAT cartridge. The open/closed state of these holes determine tape thickness, cleaning cartridge, and whether the tape is prerecorded (write-protect) or unrecorded. These mechanical sensors plus the sensor for "cartridge in" status are designed to comply with the ANSI DAT cartridge specification.

The beginning-of-tape (BOT) sensor is an optical sensor designed to detect the light path transmissivity of leader tape as specified in the ANSI 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 magneto-resistive 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.

DAT Cartridge

The 4000 and 8000 series DDS-DC products are designed to use data-grade DDS DAT 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) to ensure optimal data integrity and reliability.

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

▶ **Note:** Proper maintenance of the drive requires that the DDS head-cleaning cartridge be used every 25 hours of read/write operation and whenever the rectangular, green cartridge-in-place LED flashes during operation.

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

Both DAT data and head-cleaning cartridges can be ordered from Seagate and are packaged in multiples of five.

These small (approximately 2 inches x 3 inches x 0.4 inch) cartridges house magnetic tape that is 3.81 mm (0.150 inch) wide. The DAT cartridgesare slightly bigger than a credit card. Figure 8-6 shows the DAT cartridge.

Figure 8-6
DAT Cartridge
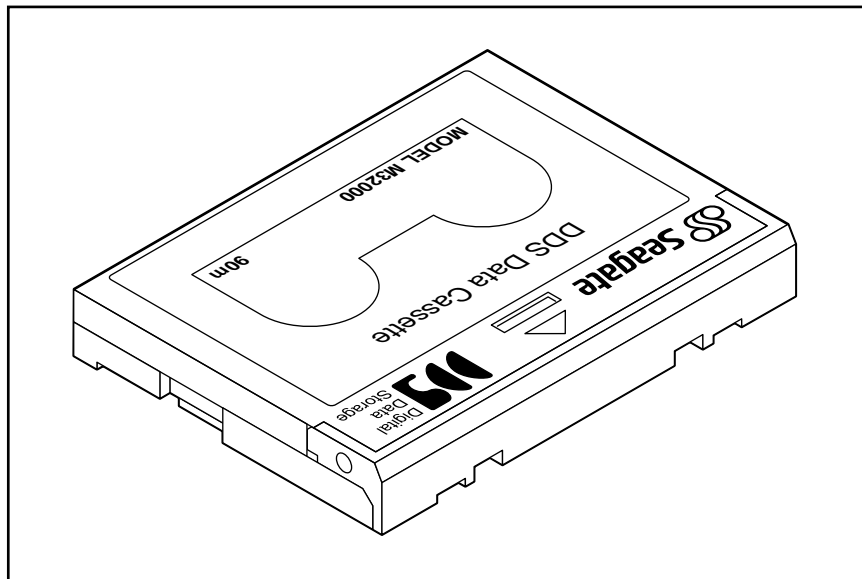
Qualified DAT cartridges are designed with specific file protect, lid, and other features for information interchange and are tested to comply with the ANSI DDS specifications.

The 8000 series drives also recognize 120 meter MP+ cartridges and other MRS cartridges when MRS is enabled. MRS cartridges have a series of alternate opaque and clear stripes at the beginning of the tape. This stripping classifies the media as data grade, rather than audio grade media. Figure 8-7 points out the four recognition holes that allow the drive sensors to identify the type of tape, its magnetic thickness, and to determine whether the tape is prerecorded or unrecorded or is a cleaning cartridge. Other cartridge features to allow the drive to optically sense "cartridge in", BOT, and EOT.

Figure 8-7
Cartridge Design Features

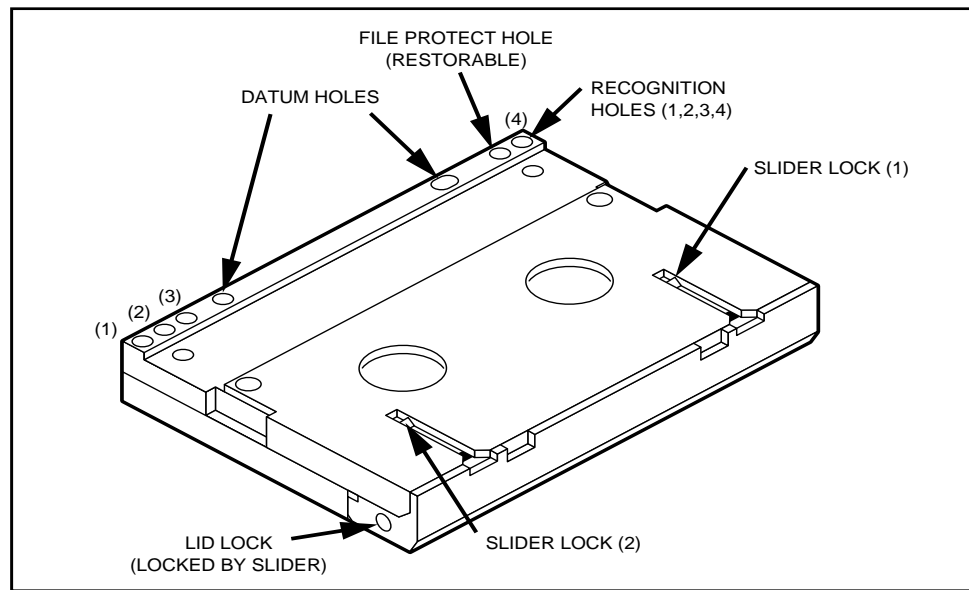The following table lists the five cartridge tape lengths that may be used with DAT products. Contact your Seagate sales representative for information about other tape lengths not listed here.

			Tape Capacity (Gigabytes)					
			Uncompressed		Compressed			
Length	Time* (minutes)				Typical		Maximum	
(meters)	DDS	DDS-2	DDS	DDS-2	DDS	DDS-2	DDS	DDS-2
120 (DDS-2)	N/A	117.0	N/A	4.0	N/A	8.0	N/A	16.0
90	61.0	N/A	2.0	N/A	4.0	N/A	8.0	N/A
60	41.0	N/A	1.3	N/A	2.7	N/A	5.2	N/A

Minutes at play or constant, streaming backup

▶ **Note:** With data compression, tape capacity depends on the characteristics of the data being compressed. "Typical capacity" reflects a 2:1 compression ration, typical of a mix of general purpose data files such as spreadsheet and word processing files. "Maximum capacity" is not an absolute maximum but rather a nominal maximum, such as with types of conventional files which can contain more redundant data, such as certain database files.

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 8-8 shows the sliding write-protect tab on the DAT 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 8-8
Write-Protect Tab on the DAT Cartridge

Maintenance and Reliability 9
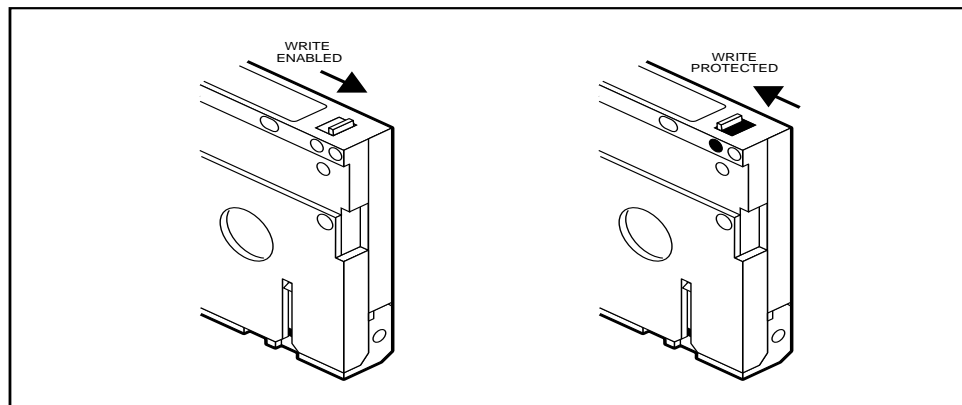
Maintenance

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

Head Cleaning

Whenever the Cartridge In Place status LED (green) flashes, you should clean the drive heads with a cleaning cartridge.

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

▶ **Note:** The slowly flashing green LED may also refer to a damaged tape or a tape 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.) Also see chapter 4 for a description of LED operation.

To clean the heads of the drive, use only an Seagate-qualified DDS DAT cleaning cartridge designed for DDS drives. Seagate offers a cleaning cartridge, Model M91301 that you may 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 immediately detects that the cartridge is a 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 will not rewind the cartridge. If the cleaning cartridge has been completely used, the drive will eject the cartridge and the amber LED will flash rapidly.

Do not use an audio DAT cleaning cartridge. It will not be properly recognized by the drive.

Automatic Drive Spin-Down and Write

In order 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 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 and 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 DAT 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—like 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 DAT products are 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
Mean-Time-To-Repair (MTTR)	Less than 0.5 hour

Mean-Time-Between Failures

The Mean-Time-Between Failures (MTBF) is 200,000 hours. This specification includes all power-on and operational time but excludes maintenance periods. Operational time is assumed to be 20% of the power-on time. Operational time is the time the tape is loaded on the cylinder (tape moving or cylinder rotating).

▶ **Note:** Seagate does not warrant the stated MTBF as representative of any particular unit installed for customer use. The failure rate quoted here 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 as qualified service technician to diagnose a defective drive and install a replacement drive. The MTTR for DAT products is less than 0.5 hour (30 minutes).

The Seagate DAT drives are field replaceable units. If a problem occurs with a subassembly or component in the drive, the entire unit should be replaced. The faulty drive should be returned to the factory in its original packaging. Contact your distributer, dealer, your computer system company, or your Seagate sales representative to arrange the return.

NOTES

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.

Timing Tracking --A method of ensuring the head is in the center of the track being read.

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 disk, diskette, or tape. Ensures against data loss.

Beginning of Media (BOM)--Equal to the physical beginning of the tape, where the leader tape is jointed 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 containing magnetic tape wound on two coplanar hubs and driven by an external drive.

Compression Ratio---The ratio comparing 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 interfering 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).

Decompression---The process of restoring compressed data to its original state.

Dictionary---The collection of representations (numeric values) of unique character strings encounteredin 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.

Disk Drive--A peripheral storage device that rotates the disk, writes data onto it, and reads data from it as instructed by a program.

DDS Format--The Digital Data Storage format for tape cartridges developed by Sony and Hewlett Packard for DAT computer peripherals.

DDS-DC Format--The Digital Data Storage Data Compression format for tape cartridges that is approved by the American national Standards Institute and the European Computer Manufacturers Association for DAT computer peripherals with data compression.

DDS-2 Format--The Digital Data Storage-2 (narrow-track) format that provides for 50 percent more tracks to be recorded to a tape

DDS-2DC Format--The Digital Data Storage-2 (narrow-track) format that provides for 50 percent more tracks to be recorded to a tape and that provides data compression.

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 jointed 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 Codes (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 Disk--A non-removable hard disk. All data must be transferred to and from the disk via the computer.

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

Full-high (or full-height)--Usually refers to a tape drive fitting in a vertical space of 3-1/2 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-high (or half-height)--Refers to the size of tape drive occupying a vertical space of about 1-1/2 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.

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.

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.

Randomizing--A recoding of data symbols before they are written to tape in order 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.

Reference & System Area---The second section of the tape on a DAT cartridge, which provides logs of usage and soft error occurrences.

Tape Drive---A peripheral storage device that records data onto removable tape cartridges. Used to back up a disk drive. (See also Disk Drive.)

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 being in error, without using any error correction techniques.

Notes

Acronyms and Measurements   *B*

Acronyms and Abbreviations

Acronym	*Meaning*
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 LempelZiv
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 Eraseable, 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	LempelZiv 1 (algorithm)
LZ2	LempelZiv 2 (algorithm)
LZW	LempelZivWelch (algorithm)
MFM	Modified Frequency Modulation
MTBF	Mean Times Between Failures

Acronym	*Meaning*
MTTR	Mean Time To Repair
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
GB	gigabyte
Hz	Hertz
in.	inch
k	kilo
KB	kilobyte
kg	kilogram
KHz	kilohertz
lb(s)	pound(s)
m	meter
M	mega
Mbits	megabits
MB	megabyte
MHz	megaHertz
min	minute
mm	millimeter
ms	millisecond
RPM	revolutions per minute
V	Volt
W	Watt

NOTES:

Vendor Unique SCSI Information

C

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 (30h). You can use the MODE SENSE command—MODE SENSE Flash Memory Configuration Page (30h)—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 30h 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 will be in effect after a power-on or SCSI reset conditions. These parameters remain vaild 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 (30h) 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:** Refer to the ***DAT Tape Drives and Autoloaders SCSI Manua***l (P/N 10002663-00x) for detailed information about the SCSI interface, including a complete command summary.

MODE SELECT Flash Memory Configuration Page (30h)

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) will 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.

					Bits			
Byte	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
0	0	0	Page Code (30h)					
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 30h 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 (30h)

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) will 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.

				Bits				
Byte	*7*	*6*	*5*	*4*	*3*	*2*	*1*	*0*
0	0	0	Page Code (30h)					
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 30h 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

NOTES: