Seagate

....

Elite 23 Disc Drive

....

ST423451N/W/WD

....

....

....

Product Manual, Volume 1

....

Elite 23 Disc Drive

ST423451N/W/WD

Product Manual, Volume 1

Revision status summary sheet

Revision	Date	Writer/Engineer	Sheets Affected
A	08/25/97	D. Ashby/B. Rathe	All

This manual is volume 1 of a two-volume document with the SCSI interface information in the volume 2 *SCSI Interface Product Manual*, **part number 77738479.**

If you need SCSI interface information, order the volume 2 *SCSI Interface Product Manual*, **part number 77738479.**

Contents

List of Figures

1.0   Scope

This manual describes Seagate Technology®, Inc. Elite 23™ disc drives.

Elite 23 drives support the small computer system interface (SCSI) as described in the ANSI SCSI, SCSI-2, and SCSI-3 (Fast-20) interface specifications to the extent described in this manual. The *SCSI Interface Product Manual* (part number 77738479) describes general SCSI interface characteristics of this and other families of Seagate drives.

From this point on in this product manual the reference to Elite 23 models is referred to as "the drive" (unless references to individual models are necessary).
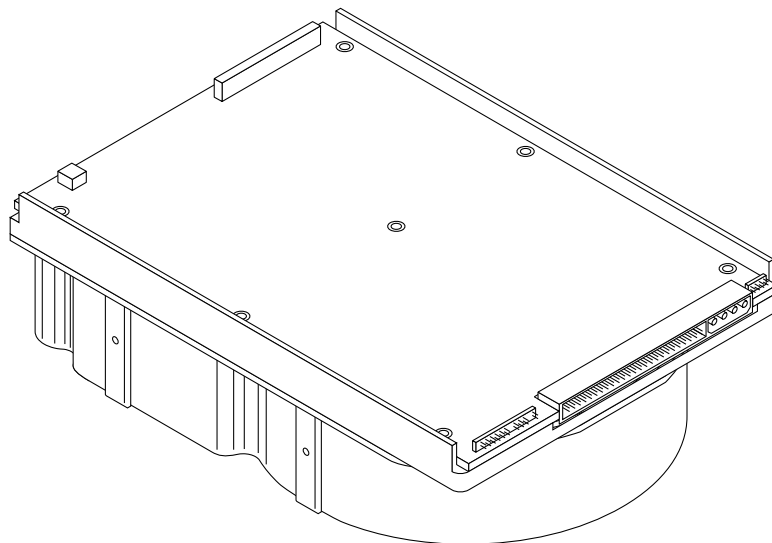
Figure 1.   Elite 23 disc drive (ST423451N drive shown)

2.0 Applicable standards and reference documentation

The drive is a system peripheral developed to the highest standards of design and construction. The drive depends on its host equipment to provide adequate power and environment to achieve optimum performance and compliance with applicable industry and government regulations. Special attention must be given in the areas of safety, power distribution, shielding, audible noise control, and temperature regulation. Also, the drive must be securely mounted to guarantee the specified performance characteristics.

2.1 Standards

The Elite 23 family complies with Seagate standards as noted in the appropriate sections of this manual and the Seagate *SCSI Interface Product Manual* (volume 2), part number 77738479.

The Elite 23 disc drive is a UL recognized component per UL1950, CSA certified to CSA C22.2 No. 950-M89, and VDE certified to VDE 0805 and EN60950.

2.1.1 Electromagnetic compatibility

The drive, as delivered, is designed for system integration and installation into a suitable enclosure prior to use. As such, the drive is supplied as a subassembly and is not subject to Subpart B of Part 15 of the FCC Rules and Regulations nor the Radio Interference Regulations of the Canadian Department of Communications.

The physical design characteristics of the drive serve to minimize radiation when installed in an enclosure that provides reasonable shielding. As such, the drive is capable of meeting the Class B limits of the FCC Rules and Regulations of the Canadian Department of Communications when properly packaged. However, it is the user's responsibility to assure that the drive meets the appropriate EMI requirements in their system. Shielded I/O cables may be required if the enclosure does not provide adequate shielding. If the I/O cables are external to the enclosure, shielded cables should be used, with the shields grounded both to the enclosure and to the host controller.

2.1.1.1 Electromagnetic susceptibility

As a component assembly, the drive is not required to meet any susceptibility performance requirements. It is the responsibility of those integrating the drive within their systems to perform those tests required and design their system to ensure that equipment operating in the same system as the drive or external to the system does not adversely affect the performance of the drive. See Section 5.1.1 and Table 2, DC power requirements.

2.2 Electromagnetic compliance

Seagate uses an independent laboratory to confirm compliance to the directives/standard(s) for CE Marking and C-Tick Marking. The drive was tested in a representative system for typical applications. The selected system represents the most popular characteristics for test platforms. The system configurations include:

- 486, Pentium, and PowerPC microprocessors
- 3.5-inch floppy disc drive
- Keyboard
- Monitor/display
- Printer
- External modem
- Mouse

Although the test system with this Seagate model complies to the directives/standard(s), we cannot guarantee that all systems will comply. The computer manufacturer or system integrator shall confirm EMC compliance and provide CE Marking and C-Tick Marking for their product.

Electromagnetic compliance for the European Union

If this model has the CE Marking it complies with the European Union requirements of the Electromagnetic Compatibility Directive 89/336/EEC of 03 May 1989 as amended by Directive 92/31/EEC of 28 April 1992 and Directive 93/68/EEC of 22 July 1993.

Australian C-Tick

If this model has the C-Tick Marking it complies with the Australia/New Zealand Standard AS/NZS3548 1995 and meets the Electromagnetic Compatibility (EMC) Framework requirements of Australia's Spectrum Management Agency (SMA).

2.3   Reference documents

Elite 23 Installation Guide   Seagate P/N 83329130

SCSI Interface Product Manual (Volume 2)   Seagate P/N 77738479

ANSI small computer system interface (SCSI) document numbers:
    X3.131-1994   SCSI-2
    X3T10/855D rev. 15a   SPI
    X3T10/1071D rev. 6   Fast-20 (also called "Ultra SCSI")

Package Test Specification   Seagate P/N 30190-001 (under 100 lb.)

Package Test Specification   Seagate P/N 30191-001 (over 100 lb.)

In case of conflict between this document and any referenced document, this document takes precedence.

3.0   General description

Elite 23 drives combine magnetoresistive (MR) heads, partial response/maximum likelihood (PRML) read channel electronics, embedded servo technology, and a SCSI-3 (Fast-20) interface to provide high performance, high capacity data storage for a variety of systems including engineering workstations, network servers, mainframes, and supercomputers.

Fast-20 (also known as Ultra SCSI) is a negotiated transfer rate. This transfer rate will occur only if your host adapter also supports Fast-20 data transfer rates. This drive also operates at SCSI-1 and SCSI-2 data transfer rates for backward compatibility with non-Fast-20 capable SCSI host adapters.

Table 1 lists the features that differentiate the various Elite 23 SCSI-3 Fast-20 (Ultra SCSI) models.

Table 1:   Drive model number vs. differentiating features

Model number	I/O circuit type	Number of I/O connector pins	Number of I/O data bus bits
ST423451N	single-ended	50	8 (fast)
ST423451W	single-ended	68	16 (fast/wide)
ST423451WD	differential	68	16 (fast/wide)

The drive records and recovers data on 5.25-inch (133.4 mm) non-removeable discs.

The drive supports the Small Computer System Interface (SCSI) as described in the ANSI SCSI-2 interface specifications to the extent described in this manual (volume 1), which defines the product performance characteristics of the Elite 23 family of drives, and the *SCSI Interface Product Manual* (volume 2), part number 77738479, which describes the general interface characteristics of this and other families of Seagate SCSI drives.

The drive's interface supports multiple initiators, disconnect/reconnect, self-configuring host software, and automatic features that relieve the host from the necessity of knowing the physical characteristics of the targets (logical block addressing is used).

The head and disc assembly (HDA) is sealed at the factory. Air circulates within the HDA through a non-replaceable filter to maintain a contamination-free HDA environment.

Refer to Figure 2 for an exploded view of the drive. This exploded view is for information only—never disassemble the HDA and do not attempt to service items in the sealed enclosure (heads, media, actuator, etc.) as this requires special facilities. The drive contains no replaceable parts. Opening the HDA voids your warranty.

Elite 23 drives use a dedicated landing zone at the innermost radius of the media to eliminate the possibility of destroying or degrading data by landing in the data zone. The drive automatically goes to the landing zone when power is removed.

An automatic shipping lock prevents potential damage to the heads and discs that results from movement during shipping and handling. The shipping lock automatically disengages when power is applied to the drive and the head load process begins.

Elite 23 drives decode track 0 location data from the servo data embedded on each surface to eliminate mechanical transducer adjustments and related reliability concerns.

A high-performance actuator assembly with a low-inertia, balanced, patented, straight-arm design provides excellent performance with minimal power dissipation.
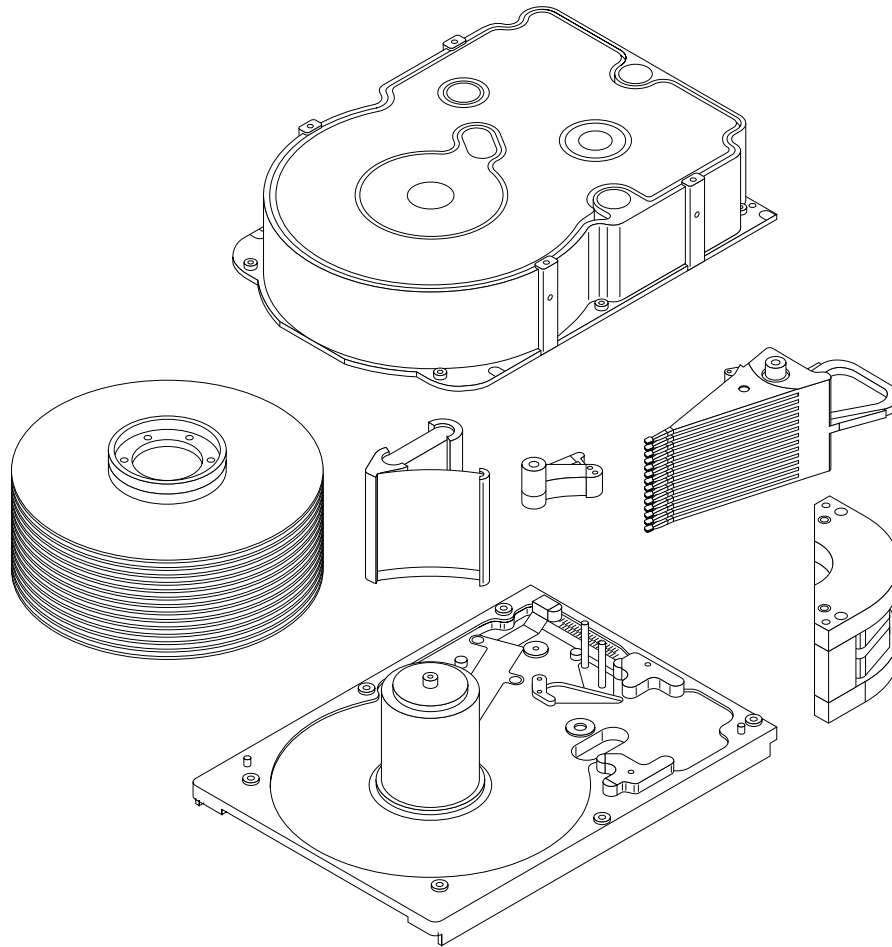
Figure 2.   Elite 23 family drive

3.1   Standard features

Elite 23 drives have the following standard features:

- Integrated SCSI controller
- Single-ended or differential SCSI drivers and receivers
- 8-bit and 16-bit I/O data bus models available
- Asynchronous and synchronous data transfer protocols
- Firmware downloadable using a SCSI interface
- Programmable drive capacity
- Selectable sector size from 512 to 4,096 bytes per sector
- Programmable sector reallocation scheme
- Flawed sector reallocation using sector slipping at format time
- Programmable auto write and read reallocation
- Reallocation of defects on command (post format)
- Reed-Solomon error-correction code for header and data fields; can correct up to 64-bit error
- Sealed head and disc assembly (HDA)
- No preventative maintenance or adjustment required
- Dedicated head-landing zone
- Embedded servo data rather than a separate servo data surface
- Self-diagnostics performed when power is applied to the drive
- 1:1 interleave
- Zone bit recording (ZBR)
- Vertical, horizontal, or top-down mounting

- Dynamic spindle brake
- Active IC terminators enabled by jumper ("N" and "W" models only)
- 2,000 Kbyte data buffer. See Section 4.5
- SCAM (SCSI Configured Auto Magically) Plug-n-Play Level 1 compliant. SCAM Level 2 is a factory-installed option.

3.2   Media characteristics

The media used on the drive has a diameter of approximately 5.25 inches (134 mm). The aluminum substrate is coated with a thin film magnetic material, overcoated with a proprietary protective layer for improved durability and environmental protection.

3.3   Performance

- Supports industry-standard Fast-20 SCSI interface (also called "Ultra SCSI")
- Programmable multi-segmentable cache buffer
- 5,400 RPM spindle; average latency = 5.55 msec
- Command queuing of up to 64 commands
- Background processing of queue
- Supports start and stop commands (spindle stops spinning)
- Low audible noise for office environment
- Low power consumption

3.4   Reliability

- 800,000 hour MTBF
- LSI circuitry
- Balanced low mass rotary voice coil actuator
- Incorporates industry-standard Self-Monitoring, Analysis and Reporting Technology (S.M.A.R.T.)
- Incorporates Seek To Improve Reliability algorithm (STIR)
- Dithering algorithm
- 5-year warranty

3.5   Unformatted and formatted capacities

Formatted capacity depends on the number of spare reallocation sectors reserved and the number of bytes per sector. The following table shows standard OEM model capacities:

	Formatted [1]	Unformatted
ST423451	23.2 Gbytes [2]	29.4 Gbytes

Notes.

[1]   Standard OEM models are formatted to have 512-byte sectors. Sector size selectable at format time. Users having the necessary equipment may modify the data block size before issuing a format command and obtain different formatted capacities than those listed. User available capacity depends on spare reallocation scheme selected. See Mode Select Command and Format Command in the *SCSI Interface Product Manual,* part number 77738479.

[2]   The number of data tracks per sparing zone and the number of alternate sectors (LBAs) per sparing zone can be determined by using the Mode Sense command and reading Mode page 03h.

3.6   Programmable drive capacity

Using the Mode Select command, the drive can change its capacity to something less than maximum. See Table 5.2.1-13 in the *SCSI Interface Product Manual*, part number 77738479. Refer to the Parameter list block descriptor number of blocks field. A value of zero in the number of blocks field indicates that the drive shall not change the capacity it is currently formatted to have. A number in the number of blocks field that is less than the maximum number of LBAs changes the total drive capacity to the value in the block descriptor number of blocks field. A value greater than the maximum number of LBAs is rounded down to the maximum capacity.

3.7   Factory installed accessories

The *Elite 23 Installation Guide*, part number 83329130, is shipped with each standard OEM drive (unless otherwise specified). A small bag of jumpers are also shipped with the drive. Use these jumpers to configure the option headers. See Section 8.1.

SCSI terminators can be enabled or disabled on "N" and "W" models.

3.8   Options (factory installed)

All options that a customer may request are incorporated during production or packaged at the manufacturing facility before shipping. Some of the options available are:

*   The capacities shown in Section 3.5. You can order other capacities by selecting other sparing schemes and sector sizes.
*   Single-unit shipping pack. The drive normally ships in bulk packaging to provide maximum protection against transit damage. Units shipped individually require additional protection as provided by the single-unit shipping pack. Specify this option if you are planning to ship single units to your customers.
*   The *Elite 23 Installation Guide*, part number 83329130, is usually included with each standard OEM drive. Additional copies may be ordered.
*   SCAM Level 2 compliance.

3.9   Accessories (user installed)

The following accessories are available.

*   Single-unit shipping pack.

4.0 Performance characteristics

4.1 Internal drive characteristics (transparent to user)

ST423451

Drive capacity	29.4 Gbyte (unformatted) [1]
Read/write heads	28
Bytes/track	152,908 Bytes (average, unformatted) [1]
Bytes/surface	1,051 Mbytes (unformatted)
Tracks/surface, total	6,876 Tracks (user accessible)
Tracks/inch	5,555 TPI
Peak bits/inch	125,360 BPI
Internal data rate	86-124 Mbits/sec (variable with zone)
Disc rotational speed	5,400 ± 0.5% r/min
Average rotational latency	5.55 msec

[1]   Rounded off values

4.2 SCSI seek performance characteristics (visible to user)

The values given in Section 4.2.1 apply to all Elite 23 models unless otherwise specified. Refer to Section 9.10 and to the *SCSI Interface Product Manual* (part number 77738479) for additional timing details.

4.2.1 Access time

		Including controller overhead (without disconnect) [1] [4]	
		Drive level	
		Read	Write
		ms	
Average	Typical [3]	13.2	14.2
Single track	Typical [3]	1.3	2.3
Full stroke	Typical [3]	28.2	28.2

4.2.2 Format command execution time (for ≥ 512-byte sectors)

Maximum (with verify)	6.5 hours
Maximum (no verify)	3.75 hours

4.2.3 General performance characteristics

Minimum sector interleave   1 to 1

Data buffer data transfer rate to/from disc media (one 512-byte sector) variable with zone/cylinder:

Minimum	[4]	86 Mbits/sec
Maximum	[4]	124 Mbits/sec

SCSI interface data transfer rate (asynchronous) [5]:

Maximum instantaneous (1-byte-wide transfer rate)	5.0 Mbytes/sec [6]
Maximum instantaneous (2-byte-wide transfer rate)	10.0 Mbytes/sec [7]

Synchronous transfer rate for SCSI Fast-20 (Ultra SCSI):

8 bit data bus models	2.5 to 20 Mbytes/sec
16 bit data bus models	5.0 to 40 Mbytes/sec

[ ] All notes for Sections 4.2 are listed at end of Section 4.2.3.

Synchronous transfer rate for fast SCSI-2:

8 bit data bus models	1.25 to 10 Mbytes/sec
16 bit data bus models	2.5 to 20 Mbytes/sec

Sector sizes:

Default	512-byte data blocks
Variable in even-sector sizes	512 to 4,096 bytes per sector

Read/write consecutive sectors on a track	Yes

Flaw reallocation performance impact:

For flaws reallocated at format time using spare
sectors per track reallocation scheme ..... negligible

For flaws reallocated after format time using spare
sectors per cylinder reallocation scheme ..... 11.1 msec (minimum)
22.2 msec (maximum)

For flaws reallocated after format time using spare
tracks per volume reallocation scheme ..... 35 msec (typical)

Overhead time for head switch (512-byte sectors)
in sequential mode ..... 0.8 msec

Overhead time for one track cylinder switch
in sequential mode ..... 1.2 msec (typical)

Average rotational latency ..... 5.55 msec

Notes for Sections 4.2.

[1] Execution time is measured from receipt of the last byte of the Command Descriptor Block (CDB) to the request for a status byte transfer to the initiator (excluding connect/disconnect).

[2] Maximum times are specified over the worst case conditions of temperature, voltage margins and drive orientation. When comparing specified access times, take care to distinguish between typical access times and maximum access times. Obtain the best comparison by conducting system benchmark tests under identical conditions. Maximum times do not include error recovery.

[3] Typical access times are measured under nominal conditions of temperature, voltage, and horizontal orientation as measured on a representative sample of drives.

[4] Assumes no errors and no sector reallocations.

[5] Rate measured from the start of the first sector transfer to or from the host.

[6] Assumes system ability to support the 1-byte-wide transfer rate listed and no cable loss.

[7] Assumes system ability to support the 2-byte-wide transfer rate listed and no cable loss.

4.3　　　　Start/stop time

Disabling the Motor Start option causes the drive to become ready within 45 seconds after DC power is applied at nominal voltage. This means the motor starts as soon as power is applied. If a recoverable error condition is detected during the start sequence, the drive will execute a recovery procedure and may cause the time to become ready to exceed 45 seconds. During this time the drive responds to some commands over the SCSI interface. Stop time is less than 40 seconds from removal of DC power.

Enabling the Motor Start option causes the internal controller to accept the commands listed in the *SCSI Interface Product Manual* (77738479) less than 3 seconds after applying DC power. After receiving the Motor Start command, the drive becomes ready for normal operations within 45 seconds (excluding an error recovery procedure). The Motor Start command can also be used to command the drive to stop the spindle in less than 40 seconds (see the Start/Stop command information in the *SCSI Interface Product Manual).*

There is no power control switch on the drive.

4.4　　　　Prefetch/multi-segmented cache control

The drive provides prefetch (read look-ahead) and multi-segmented cache control algorithms that in many cases can enhance system performance. "Cache" as used herein refers to the drive buffer storage space when it is used in "cache" operations. To select prefetch and cache features the host sends the Mode Select command with the proper values in the applicable bytes in Mode Page 08h (see *SCSI Interface Product Manual*). Prefetch and cache operation are independent features from the standpoint that each is enabled and disabled independently via the Mode Select command. However, in actual operation the prefetch feature overlaps cache operation somewhat as is noted in Section 4.5.1 and 4.5.2.

All default cache and prefetch Mode parameter values (Mode Page 08h) for standard OEM versions of this drive family are given in Table 8.

4.5　　　　Cache operation

Of the 2,048 Kbytes physical buffer space, approximately 1,442 Kbytes can be used as a cache. The cache can be divided into logical segments (Mode Select page 08h, byte 13) from which data is read and to which data is written.

The drive keeps track of the logical block addresses of the data stored in each segment of the cache. If the cache is enabled (see RCD bit = 0 in Mode page 08h, byte 2, bit 0 in the *SCSI Interface Product Manual),* data requested by the host with a read command is retrieved from the cache, if possible, before any disc access is initiated. If cache operation is not enabled, the buffer (still segmented with required number of segments) is still used, but only as circular buffer segments during disc medium read operations (disregarding Prefetch operation for the moment). That is, the drive does not check in the buffer segments for the requested read data, but goes directly to the medium to retrieve it. The retrieved data merely passes through some buffer segment on the way to the host. On a cache "miss," all data transfers to the host are in accordance with "buffer-full" ratio rules. On a cache "hit," the drive ignores the "buffer-full" ratio rules. See explanations associated with Mode page 02h (disconnect/reconnect control) in the *SCSI Interface Product Manual*.

The following is a simplified description of a read operation with cache operation enabled:

Case A - Read command is received and the first logical block is already in the cache.

1.　Drive transfers to the initiator the first logical block requested plus all subsequent contiguous logical blocks that are already in the cache. This data may be in multiple segments.

2.　When a requested logical block is reached that is not in any segment, the drive fetches it and any remaining requested logical block addresses from the disc and puts them in a segment of the cache. The drive transfers the remaining requested logical blocks from the cache to the initiator in accordance with the "buffer-full" ratio specification given in Mode Select Disconnect/Reconnect parameters, page 02h (see the *SCSI Interface Product Manual).*

3.　The drive prefetches additional logical blocks contiguous to those transferred in step 2 above and stores them in the segment. The drive stops filling the segment when the maximum prefetch value has been transferred (see the *SCSI Interface Product Manual).*

Case B - Read command is received and the first logical block address requested is not in any segment of the cache.

1. The drive fetches the requested logical blocks from the disc and transfers them into a segment, then from there to the initiator in accordance with the "buffer-full" ratio specification given in Mode Select Disconnect/ Reconnect parameters, page 02h (see the *SCSI Interface Product Manual*).

2. The drive prefetches additional logical blocks contiguous to those transferred in Case A, step 2 above and stores them in the segment. The drive stops filling the segment when the maximum prefetch value has been transferred.

During a prefetch, the drive crosses a cylinder boundary to fetch data only if the Discontinuity (DISC) bit is set to 1 in bit 4 of byte 2 of the Mode Select parameters page 08h. Default is zero for bit 4 (see the *SCSI Interface Product Manual*).

Each buffer segment is actually a self-contained circular storage (wrap-around occurs), the length of which is an integer number of disc medium sectors. The wrap-around capability of the individual segments greatly enhances the buffer's overall performance as a cache storage, allowing a wide range of user selectable configurations, which includes their use in the prefetch operation (if enabled), even when cache operation is disabled (see Section 4.5.2). The number of segments may be selected using the Mode Select command, but the size cannot be directly selected. Size is selected only as a by-product of selecting the segment number specification. The size in Kbytes of each segment is not reported by the Mode Sense command page 08h, bytes 14 and 15. These bytes read 0xFFFF, regardless of the number of segments setting. If a size specification is sent by the host in a Mode Select command (bytes 14 and 15) no new segment size is set up by the drive, and if the "STRICT" bit in Mode page 00h (byte 2, bit 1) is set to one, the drive responds as it does for any attempt to change unchangeable parameters (see *SCSI Interface Product Manual*). The drive supports operation of any integer number of segments from 1 to 16. Divide the 1,442 Kbytes in the buffer by the number of segments to calculate the segment size. The default is three segments.

4.5.1   Caching write data

When the WCE (Write Cache Enable) bit is enabled, the drive uses a drive buffer storage area where the data to be written to the drive is stored in one or more segments while the drive performs the Write command. The write cache uses the same buffer space and segmentation as the read cache. The buffer segmentation scheme is set up or changed independently, having nothing to do with whether or not read and write caching is enabled or disabled.

If a 10-byte CDB write command (2Ah) is issued with the DPO (Data Page Out) bit set to one, no write data is cached but the cache segments are still checked and cleared (if needed) for any logical blocks that are being written.

When a write command is issued, the cache is first checked to see if any logical blocks that are to be written are already stored in the cache from a previous read or write command. If there are, the respective cache segments are cleared. The new data is cached for subsequent read commands.

If the number of write data logical blocks exceeds the size of the segment being written into when the end of the segment is reached, the data is written into the beginning of the same cache segment, overwriting the data that was written there at the beginning of the operation. However, the drive does not overwrite data that has not yet been written to the disc.

Table 8 shows Mode default settings for the drives.

Note.   The WCE bit is disabled by default on OEM drives. To enable the WCE bit, change Mode Sense Page 08h, byte 2, bit 2 to a value of 1.

4.5.2   Prefetch operation

If the Prefetch feature is enabled, data in contiguous logical blocks on the disc immediately beyond that which was requested by a read command can be retrieved and stored in the buffer for immediate transfer from the buffer to the host on subsequent read commands that request those logical blocks (this is true even if "cache" operation is disabled). Though the prefetch operation uses the buffer as a "cache," finding the requested data in the buffer is a prefetch "hit," not a "cache" operation "hit." Prefetch is enabled using Mode Select page 08h, byte 12, bit 5 (Disable Read Ahead - DRA bit). DRA bit = 0 enables prefetch. Since data that is prefetched replaces data already in some buffer segment(s), the host can limit the amount of prefetch data to optimize

system performance. The max prefetch field (bytes 8 and 9) limits the amount of prefetch. The drive does not use the prefetch "ceiling" field (bytes 10 and 11).

During a prefetch operation, the drive crosses a cylinder boundary to fetch more data only if the Discontinuity (DISC) bit is set to one in bit 4 of byte 2 of Mode parameters page 08h.

Whenever prefetch (read look-ahead) is enabled (enabled by DRA = 0), it operates under the control of ARLA (Adaptive Read Look-Ahead). If the host uses software interleave, ARLA enables prefetch of contiguous blocks from the disk when it senses that a prefetch "hit" will likely occur, even if two consecutive read operations were not for physically contiguous blocks of data (e.g. "software interleave"). ARLA disables prefetch when it decides that a prefetch "hit" will not likely occur. If the host is not using software interleave, and if two sequential read operations are not for contiguous blocks of data, ARLA disables prefetch, but as long as sequential read operations request contiguous blocks of data, ARLA keeps prefetch enabled.

5.0 Reliability specifications

The following reliability specifications assume correct host/drive operational interface, including all interface timings, power supply voltages, environmental requirements and drive mounting constraints (see Section 8.4).

Seek errors	Less than 10 in 10^8 seeks
Read error rates [1]	
Recovered data	Less than 10 errors in 10^{11} bits transferred (OEM default settings)
Unrecovered data	Less than 1 sector in 10^{14} bits transferred (OEM default settings)
Miscorrected data	Less than 1 sector in 10^{21} bits transferred
MTBF	800,000 hours
Service life	5 years
Preventive maintenance	None required

Note.

[1]   Error rate specified with automatic retries and data correction with ECC enabled and all flaws reallocated.

5.1 Error rates

The error rates stated in this specification assume the following:

• The drive is operated per this specification using DC power as defined in this manual (see Section 6.2).

• The drive has been formatted with the SCSI format commands.

• Errors caused by media defects or host system failures are excluded from error rate computations. Refer to Section 3.2, "Media Characteristics."

• Data is random.

5.1.1 Environmental interference

When evaluating systems operation under conditions of Electromagnetic Interference (EMI), the performance of the drive within the system is considered acceptable if the drive does not generate an unrecoverable condition.

An unrecoverable error, or condition, is defined as one that:

• is not detected and corrected by the drive itself;

• is not capable of being detected from the error or fault status provided through the drive or SCSI interface; or

• is not capable of being recovered by normal drive or system recovery procedures without operator intervention.

5.1.2 Read errors

Before determination or measurement of read error rates:

• The data that is to be used for measurement of read error rates must be verified as being written correctly on the media.

• All media defect induced errors must be excluded from error rate calculations.

5.1.3 Write errors

Write errors can occur as a result of media defects, environmental interference, or equipment malfunction. Therefore, write errors are not predictable as a function of the number of bits passed.

If an unrecoverable write error occurs because of an equipment malfunction in the drive, the error is classified as a failure affecting MTBF. Unrecoverable write errors are those which cannot be corrected within two attempts at writing the record with a read verify after each attempt (excluding media defects).

5.1.4   Seek errors

A seek error is defined as a failure of the drive to position the heads to the addressed track. There should not be more than 10 recoverable seek errors in 10^8 physical seek operations. After detecting an initial seek error, the drive automatically performs an error recovery process. If the error recovery process fails, a seek position-ing error (15h) is reported with a Medium (3h) or Hardware error (4h) reported in the Sense Key. This is an unrecoverable seek error. Unrecoverable seek errors are classified as failures for MTBF calculations. Refer to Section 5.1.1.4 of *SCSI Interface Product Manual* (part number 77738479).

5.2   Reliability and service

You can enhance the reliability of Elite 23 disc drives by ensuring that the drive receives adequate cooling. Section 6.4.1 provides temperature measurements and other information that may be used to enhance the ser-vice life of the drive. Section 8.3.1 provides recommended air-flow information.

5.2.1   Mean time between failure

The production disc drive achieves an MTBF of 800,000 hours when operated in an environment that ensures the case temperatures specified in Table 3, column 2 are not exceeded. Short-term excursions up to the spec-ification limits of the operating environment will not affect MTBF performance.

The following expression defines MTBF:

$$\text{MTBF per measurement period} \quad = \quad \frac{\text{Estimated power-on operating hours in the period}}{\text{Number of drive failures in the period}}$$

Estimated power-on operation hours means power-up hours per disc drive times the total number of disc drives in service. Each drive accumulates at least nine months of operation. Data is calculated on a rolling average base for a minimum period of six months.

Drive failure means any stoppage or substandard performance caused by drive malfunction.

5.2.2   Preventive maintenance

No routine scheduled preventive maintenance shall be required.

5.2.3   Service life

The drive has a useful service life of 5 years. Depot repair or replacement of major parts is permitted during the lifetime (see Section 5.2.4).

5.2.4   Service philosophy

Special equipment is required to repair the drive HDA. To achieve the 5-year service life, repairs must be per-formed only at a properly equipped and staffed service and repair facility. Troubleshooting and repair of PCBs in the field is not recommended because of the extensive diagnostic equipment required for effective servicing. Also, there are no spare parts available for this drive. The drive warranty is voided if the HDA is opened.

5.2.5   Service tools

No special tools are required for site installation or recommended for site maintenance. Refer to Section 5.2.4. The depot repair philosophy of the drive precludes the necessity for special tools. Field repair of the drive is not practical because users cannot purchase individual parts for the drive.

5.2.6 S.M.A.R.T.

S.M.A.R.T. is an acronym for Self-Monitoring Analysis and Reporting Technology. This technology is intended to recognize conditions that indicate a drive failure and is designed to provide sufficient warning of a failure to allow data back-up before an actual failure occurs.

Note. The firmware will monitor specific attributes for degradation over time but cannot predict instantaneous drive failures.

Each attribute has been selected to monitor a specific set of failure conditions in the operating performance of the drive, and the thresholds are optimized to minimize "false" and "failed" predictions.

Controlling S.M.A.R.T.

The operating mode of S.M.A.R.T. is controlled by the DEXCPT bit and the PERF bit of the "Informational Exceptions Control Mode Page" (1Ch). The DEXCPT bit is used to enable or disable the S.M.A.R.T. process. Setting the DEXCPT bit will disable all S.M.A.R.T. functions. When enabled, S.M.A.R.T. will collect on-line data as the drive performs normal read/write operations. When the PERF bit is set, the drive is considered to be in "On-line Mode Only" and will not perform off-line functions.

The process of measuring off-line attributes and saving data can be forced by the RTZ command. Forcing S.M.A.R.T. will reset the timer so that the next scheduled interrupt will be two hours.

The drive can be interrogated by the host to determine the time remaining before the next scheduled measurement and data logging process will occur. This is accomplished by a log sense command to log page 0x3E. The purpose is to allow the customer to control when S.M.A.R.T. interruptions occur. As described above, forcing S.M.A.R.T by the RTZ command will reset the timer.

Performance impact

S.M.A.R.T. attribute data will be saved to the disc for the purpose of recreating the events that caused a predictive failure. The drive will measure and save parameters once every two hours subject to an idle period on the SCSI bus. The process of measuring off-line attribute data and saving data to the disc is uninterruptable and the maximum delay is summarized below:

Maximum processing delay

	On-line only delay	Fully enabled delay
S.M.A.R.T. delay times	60 milliseconds	450 milliseconds

Reporting control

Reporting is controlled in the "Informational Exceptions Control Page" (1Ch). Subject to the reporting method, the firmware will issue to the "host" an 01-5D00 sense code. The error code is preserved through bus resets and power cycles.

Determining rate

S.M.A.R.T. monitors the rate at which errors occur and signals a predictive failure if the rate of degraded error rate increases to an unacceptable level. To determine rate, error events are logged and compared to the number of total operations for a given attribute. The interval defines the number of operations over which to measure the rate. The counter that keeps track of the current number of operations is referred to as the Interval Counter.

S.M.A.R.T. measures error rate, hence for each attribute the occurrence of an "error" is recorded. A counter keeps track of the number of errors for the current interval. This counter is referred to as the Failure Counter.

Error rate is simply the number of errors per operation. The algorithm that S.M.A.R.T. uses to record rates of error is to set thresholds for the number of errors and the interval. If the number of errors exceeds the threshold before the interval expires, then the error rate is considered to be unacceptable. If the number of errors does not exceed the threshold before the interval expires, then the error rate is considered to be acceptable. In either case, the interval and failure counters are reset and the process starts over.

Predictive failures

S.M.A.R.T. signals predictive failures when the drive is performing unacceptably for a period of time. The firmware keeps a running count of the number of times the error rate for each attribute is unacceptable. To accomplish this, a counter is incremented whenever the error rate is unacceptable and decremented (not to exceed zero) whenever the error rate is acceptable. Should the counter continually be incremented such that it reaches the predictive threshold, a predictive failure is signaled. This counter is referred to as the Failure History Counter. There is a separate Failure History Counter for each attribute.

5.2.7   Product warranty

Beginning on the date of shipment to customer and continuing for a period of 5 years, Seagate warrants that each product (including components and subassemblies) or spare part that fails to function properly under normal use due to defect in materials on workmanship or due to nonconformance to the applicable specifications will be repaired or replaced, at Seagate's option and at no charge to customer, if returned by customer at customer's expense to Seagate's designated facility in accordance with Seagate's Warranty Procedure. Seagate will pay for transporting the repair or replacement item to customer. For more detailed warranty information, refer to the Standard Terms and Conditions of Purchase for Seagate products.

Shipping

When transporting or shipping a drive, a Seagate approved container must be used. Keep your original box. They are easily identified by the Seagate Approved Package label. Shipping a drive in a non-approved container voids the drive warranty.

Seagate repair centers may refuse receipt of components improperly packaged or obviously damaged in transit. Contact your Authorized Seagate Distributor to purchase additional boxes. Seagate recommends shipping by an air-ride carrier experienced in handling computer equipment.

Product repair and return information

Seagate customer service centers are the only facilities authorized to service Seagate drives. Seagate does not sanction any third-party repair facilities. Any unauthorized repair or tampering with the factory-seal voids the warranty.

6.0 Physical/electrical specifications

This section provides information relating to the physical and electrical characteristics of Elite 23 drives.

6.1 AC power requirements

None.

6.2 DC power requirements

The voltage and current requirements for a single drive are shown in the following table. Values indicated apply at the drive's power connector. The power requirements for single-ended models includes the internal disc drive SCSI I/O termination. Current values are in Amperes.

Table 2: DC power requirements

	Notes	ST423451N/W Single-ended		ST423451WD Differential	
Voltage		+5 V [8]	+12 V	+5 V [8]	+12 V
Regulation	[5]	±5%	±5%[2]	±5%	±5%[2]
Maximum operating current DC3σ	[1]	1.0	1.8	1.3	1.8

Maximum starting current
  Peak DC DC3σ
  Peak AC AC3σ
	[3]
	[3]
		1.0	4.8 [6]
			5.12
				1.05	4.8 [6]
					5.12

Delayed motor start (max) DC3σ	[1] [4]	.85	.1	.85	.1

Peak operating current
  Typical DC$\overline{X}$
  Maximum DC3σ
  Maximum (peak) AC3σ
	[1] [7]
	[1]
		.98
		1.0
		1.1
			1.6
			1.8
			2.8
				1.2
				1.25
				1.95
					1.6
					1.8
					2.8

Track following at
  OD DC$\overline{X}$
  ID DC$\overline{X}$
	[1]
	[1]
		.97
		.96
			1.5
			1.8
				1.05
				1.00
					1.5
					1.8

Read Track
  OD DC3σ
  AC3σ
	[1] [10]	1.0
		1.1
			1.7
			1.9
				1.46
				2.00
					1.7
					1.9

Seeking
  Typical DC$\overline{X}$
  Maximum DC3σ
  Maximum (peak) AC3σ
	[1] [9]
	[1]
		.96
		1.0
		1.1
			1.95
			2.1
			2.8
				1.05
				1.1
				1.65
					1.95
					2.1
					2.8

Notes.

[1] Measured with average reading DC ammeter. Instantaneous +12 V current peaks will exceed these values.

[2] A drop of −10% is permissible during initial start of spindle, and must return to ±5% before 5,400 rpm is reached. The ±5% must be maintained after the drive signifies that its power-up sequence has been completed and that the drive is able to accept selection by the host initiator.

[3] See +12 V current profile in Figure 3.

[4] This condition occurs when the Motor Start Option is enabled and the drive has not yet received a Start Motor command.

[5] See Section 6.2.1, "Conducted Noise Immunity." Specified voltage tolerance is inclusive of ripple, noise, and transient response.

[6] At power-up, the motor current regulator limits the 12 volt current to an average value of less than the value given here, although instantaneous peaks may exceed this value. These peaks should measure 5 msec duration or less.

[7] Operating condition is defined as a third-stroke seek at OD and Read One track. A command is issued every 0.067 seconds.

[8] No terminator power supplied to terminators by drive.

[9] Seeking is defined as a third-stroke seek at OD. A command is issued every 20 msec.

[10] Read track is defined as repeat reads of track 15 with a duty cycle of 63% for narrow single-ended.

General Notes from Table 2:

1. Minimum current loading for each supply voltage is not less than 4% of the maximum operating current shown.

2. The +5 and +12 volt supplies shall employ separate ground returns.

3. Where power is provided to multiple drives from a common supply, careful consideration for individual drive power requirements should be noted. Where multiple units are powered on simultaneously, the peak starting current must be available to each device.

6.2.1 Conducted noise immunity

Noise is specified as a periodic and random distribution of frequencies covering a band from DC to 10 MHz. Maximum allowed noise values given below are peak to peak measurements and apply at the drive power connector.

+5 V = 150 mV pp from 0 to 100 kHz and 100 mV pp from 100 kHz to 10 MHz.

+12 V = 150 mV pp from 0 to 100 kHz and 100 mV pp from 100 kHz to 10 MHz.

6.2.2 Power sequencing

The drive does not require power sequencing. The drive protects against inadvertent writing during power-up and down. Daisy-chain operation requires that power be maintained on the terminated device to ensure proper termination of the peripheral I/O cables. To automatically delay motor start based on the target ID (SCSI ID) enable the Spinup Delay option (install jumper) and disable the Start Command option (remove jumper) on the J4B connector. See Section 8.1 for pin selection information. To delay the motor until the drive receives a Start Unit command, enable the Enable Motor Start option on the J4B connector.

6.2.3 12 V current profile

Figure 3 identifies the drive +5 V and +12 V current profile. The current during the various times is as shown.
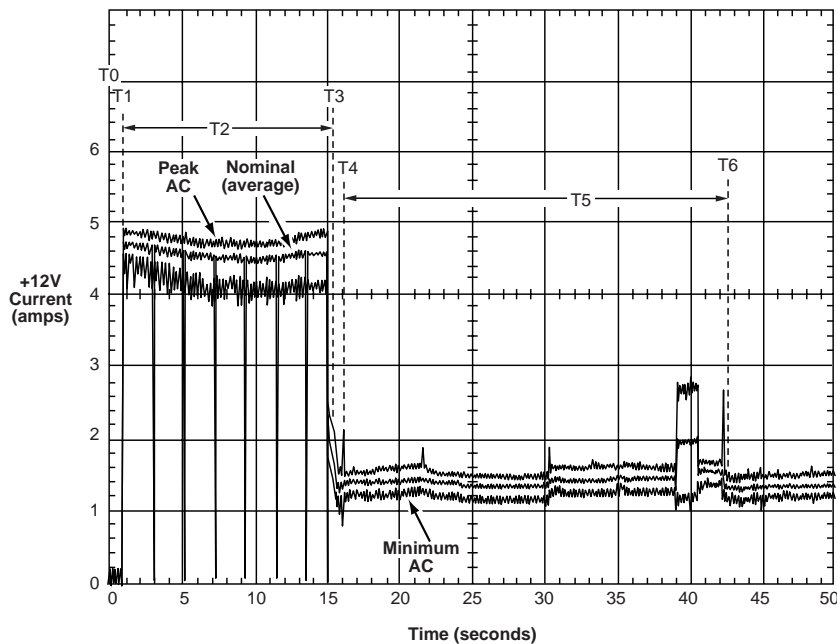

Figure 3. **Typical Elite 23 drive +5 V and +12 V current profile**

T0 - Power is applied to the drive.

T1 - Controller self-tests are performed.

T2 - Spindle begins to accelerate under current limiting after performing drive internal diagnostics. See Note 9 of Table 2.

T3 -   The spindle is up to speed and the head-arm restraint is unlocked.

T4 -   Heads move from the landing zone to the data area.

T5 -   The adaptive calibration sequence is performed.

T6 -   Calibration is complete and the drive is ready for reading and writing.

Note.   All times and currents are typical. See Table 2 for maximum current requirements.

6.3   Power dissipation

ST423451N/W

For drives with single-ended interface circuits, typical operating random read power dissipation is 24 watts (82 BTUs per hour) of DC power average at nominal voltages.

ST423451WD

For drives with differential interface circuits, typical operating random read power dissipation is 25 watts (85 BTUs per hour) of DC power average at nominal voltages.

6.4   Environmental limits

Temperature and humidity values experienced by the drive must be such that condensation does not occur on any drive part. Altitude and atmospheric pressure specifications are referenced to a standard day at 58.7°F (14.8°C). Maximum wet bulb temperature is 82°F (28°C).

6.4.1   Temperature

a. Operating

The drive meets all specifications over a 41°F to 122°F (5°C to 50°C) drive ambient temperature range with a maximum gradient of 36°F (20°C) per hour. The enclosure for the drive should be designed such that the temperatures at the locations specified in Table 3, column 1 are not exceeded. Air flow may be needed to achieve these temperature values. Operation at case temperatures above these values may adversely affect the drives ability to meet specifications.

The MTBF specification for the drive is based on operating at an ambient temperature of 86°F (30°C). Occasional excursions to drive ambient temperatures of 122°F (50°C) or 41°F (5°C) may occur without impact to specified MTBF. To achieve the specified MTBF, the enclosure for the drive should be designed such that the temperature values of Table 3, column 2 are not exceeded. Air flow may be needed to achieve these temperatures. See Section 8.3.1. Continual or sustained operation at case temperatures above these values may degrade MTBF.

To confirm that the required cooling for the drive electronics and HDA is provided, place the drive in its final mechanical configuration, perform random write/read operations and, after the temperatures stabilize, measure the case temperature of the components listed on the next several pages.

To obtain the maximum temperature for each of the reference components listed (Column 1), 27°F (15°C) was added to the temperatures of Column 2. Operation of the drive at the maximum case temperature is intended for short time periods only. Continuous operation at the elevated temperatures will reduce product reliability.

Table 3: PCB and HDA temperatures

Component	Figure 4 reference	Column 1 Maximum case [4] temperature (°C) operating (50°C ambient) [2]	Column 2 Typical case [4] temperature (°C) at 35°C ambient [1]
ADC	1	131°F (55°C)	104°F (40°C)
SCSI Controller	2	149°F (65°C)	122°F (50°C)
Barnum	3	151°F (66°C)	124°F (51°C)
Motor Controller	4	144°F (62°C)	117°F (47°C)
HDA housing [3]		140°F (60°C)	45°C

Note.

[1]   The air-flow pattern with which the temperature guidelines in Column 2 were generated is shown in Figure 11. Local average air velocities were 200 lfpm and inlet air temperature to the drive was 86°F (30°C), plus a 9°F (5°C) temperature rise in the test enclosure (86°F/30°C ambient local to the drive).

[2]   The temperatures in Column 1 are calculated and may not reflect actual operating values. Sufficient cooling air may be required to ensure that these values are not exceeded.

[3]   Measure HDA temperature at point labeled "HDA Temp. Checkpoint" on Figure 4.

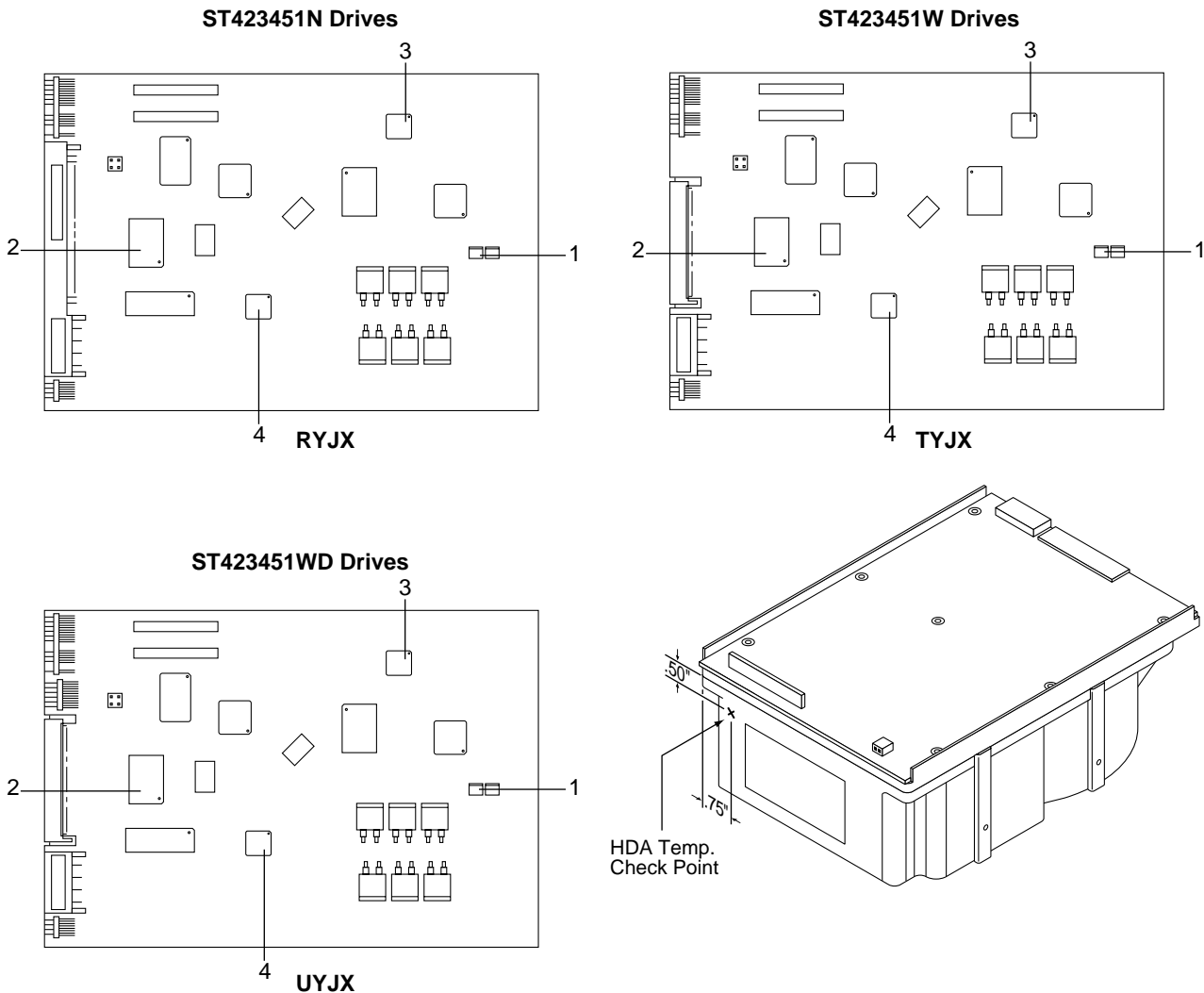[4]   PCB mounted integrated circuit case.

Figure 4.   Location of PCB components listed in Table 3

b. Non-operating

Non-operating temperature should remain between –40° to 158°F (–40° to 70°C) package ambient with a maximum gradient of 36°F (20°C) per hour. This assumes that the drive is packaged in the shipping container designed by Seagate.

6.4.2 Relative humidity

The values below assume that no condensation on the drive occurs.

a. Operating

5% to 90% non-condensing relative humidity with a maximum gradient of 10% per hour.

b. Non-operating/transit

5% to 95% non-condensing relative humidity with a maximum gradient of 10% per hour.

6.4.3 Effective altitude (sea level)

a. Operating

–1,000 to +10,000 feet (–305 to +3,048 meters)

b. Non-operating

–1,000 to +40,000 feet (–305 to +12,210 meters)

6.4.4 Shock and vibration

Shock and vibration limits specified in this document are measured directly on the drive. If the drive is installed in an enclosure to which the stated shock and/or vibration criteria is applied, resonances may occur internally to the enclosure resulting in drive movement in excess of the stated limits. If this situation is apparent, it may be necessary to modify the enclosure to minimize drive movement.

The limits of shock and vibration defined within this document are specified with the drive mounted by any of the four methods shown in Figure 5, and in accordance with the restrictions of Section 8.4. Orientation of the side nearest the LED may be up or down.

6.4.4.1 Shock

a. Operating—normal

The drive, as installed for normal operation, will operate error-free while subjected to intermittent shock not exceeding 2.0 g at a maximum duration of 11 msec (half sinewave). Shock may be applied in the X, Y, or Z axis.

b. Operating—abnormal

Equipment, as installed for normal operation, does not incur physical damage while subjected to intermittent shock not exceeding 7.5 g at a maximum duration of 11 msec (half sinewave). Shock occurring at abnormal levels may promote degraded operational performance during the abnormal shock period. Specified operational performance will continue when normal operating shock levels resume. Shock may be applied in the X, Y, or Z axis. Shock is not to be repeated more than two times per second.

c. Non-operating

The limits of non-operating shock applies to all conditions of handling and transportation. This includes both isolated drives and integrated drives.

The drive subjected to non-repetitive shock not exceeding 40 g at a maximum duration of 11 msec (half sinewave) does not exhibit device damage or performance degradation. Shock may be applied in the X, Y, or Z axis.

d. Packaged

Disc drives shipped as loose load (not palletized) general freight will be packaged to withstand drops from heights as defined in the table below. For additional details, refer to Seagate specifications 30190-001 (under 100 lbs/45 kg) or 30191-001 (over 100 lbs/45 kg).

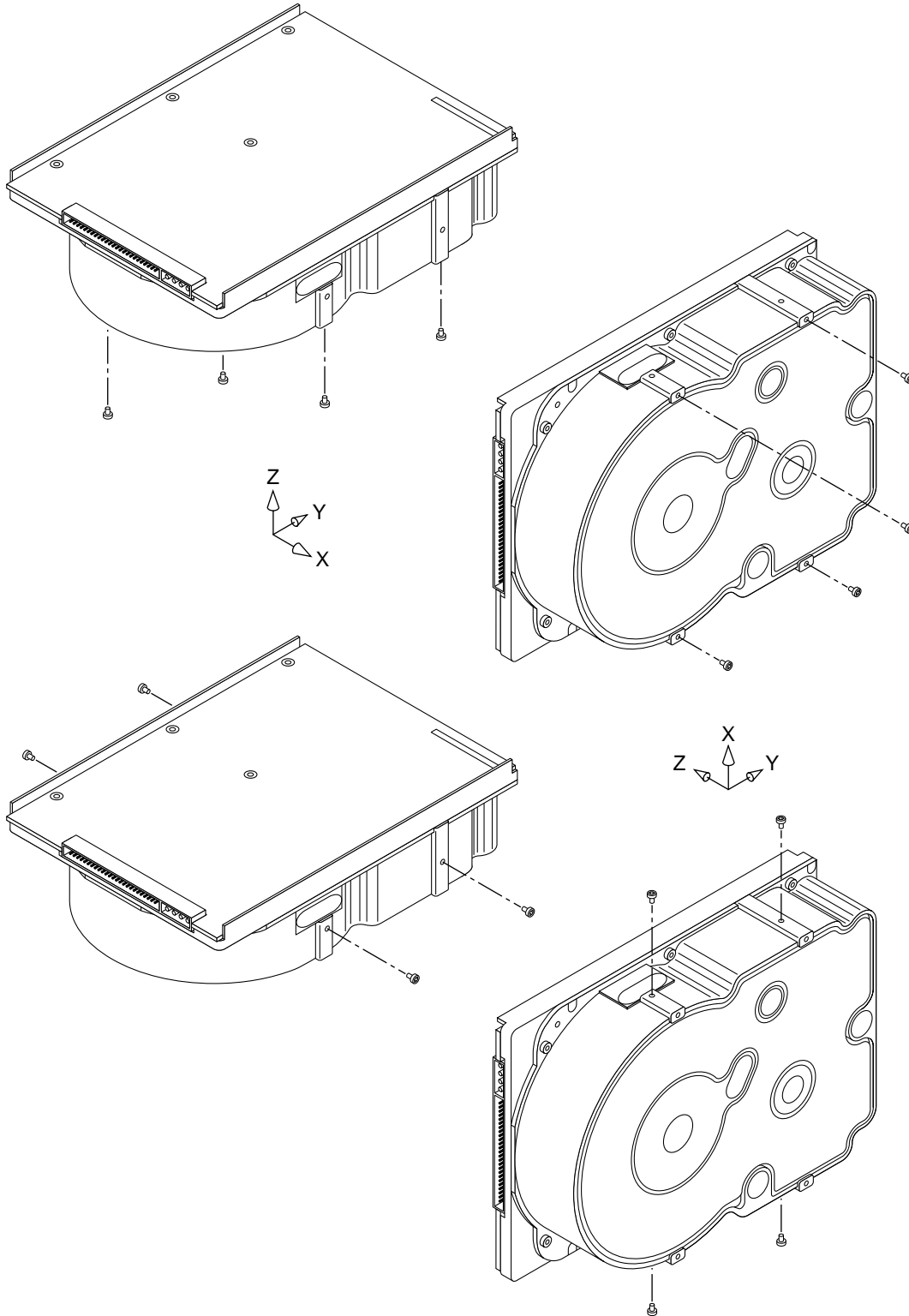| Package Size	Packaged/Product Weight	Drop Height
<600 cu in (<9,800 cu cm)	Any	60 in (1,524 mm)
600-1,800 cu in (9,800-19,700 cu cm)	0-20 lb (0-9.1 kg)	48 in (1,219 mm)
>1,800 cu in (>19,700 cu cm)	0-20 lb (0-9.1 kg)	42 in (1,067 mm)
>600 cu in (>9,800 cu cm)	20-40 lb (9.1-18.1 kg)	36 in (914 mm)

Figure 5.   **Recommended mounting**

6.4.4.2 Vibration

a. Operating—normal

The drive, as installed for normal operation, complies with the complete specified performance while subjected to continuous vibration not exceeding:

> 5-300 Hz @ 0.5 g (X, Y, or Z axis)

b. Operating—abnormal

Equipment, as installed for normal operation, does not incur physical damage while subjected to periodic vibration not exceeding:

> 5-300 Hz @ 0.75 g (X, Y, or Z axis)
> 15 minutes of duration at major resonant frequency

Vibration occurring at these levels may degrade operational performance during the abnormal vibration period. Specified operational performance will continue when normal operating vibration levels are resumed. This assumes system recovery routines are available.

c. Non-operating

The limits of non-operating vibration apply to all conditions of handling and transportation. This includes both isolated drives and integrated drives.

The drive does not incur physical damage or degraded performance as a result of continuous vibration not exceeding:

> 5-22 Hz @ 0.040 inches (1.02 mm) displacement
> 22-400 Hz @ 1.00 g

Vibration may be applied in the X, Y, or Z axis.

6.4.5 Air cleanliness

The drive is designed to operate in a typical office environment with minimal environmental control.

6.4.6 Acoustics

Sound power during idle shall be 4.6 bels typical when measured to ISO 7779 specification. No prominent tones are allowed.

6.4.7 Electromagnetic susceptibility

See Section 2.1.

6.5 Mechanical specifications

The following nominal dimensions are exclusive of the decorative front panel accessory. However, dimensions of the front panel are shown in the figure below. Refer to Figures 6 and 7 for detailed mounting configuration dimensions. See Section 8.4, "Drive mounting."

	Typical	**Maximum**
Height:	3.25 in (82.6 mm)	3.268 in (83.0 mm)
Width:	5.75 in (146.1 mm)	5.76 in (146.3 mm)
Depth:	8.0 in (203.0 mm)	8.01 in (203.5 mm)
Weight:	7.0 pounds (3.17 kilograms)	–

Notes:

[1] Mounting holes two on each side, 6-32 UNC. Max screw length into side of drive 0.17 in. (4.318 mm).

[2] Mounting holes four on bottom, 6-32 UNC. Max screw length into bottom of drive 0.18 in. (4.572 mm).

[3] Power and interface connections.

[4] Decorative front panel.

	Inches			Millimeters	
A	8.000	±	0.010	203.20	± .25
B	5.750	±	0.010	145.05	± .25
C	2.875	±	0.010	73.02	± .25
D	2.950	±	0.020	54.93	± .50
E	3.120	±	0.010	79.25	± .25
F	0.860	±	0.005	21.84	± .13
G	5.500	±	0.010	139.70	± .25
H	0.125	±	0.010	2.17	± .25
J	3.120	±	0.010	79.24	± .25
K	2.950	±	0.020	74.93	± .50
L	3.248	±	0.020	82.52	± .50

Figure 6.   Mounting configuration dimensions for "N" models

Notes:

[1] Mounting holes two on each side, 6-32 UNC. Max screw length into side of drive 0.17 in. (4.318 mm).

[2] Mounting holes four on bottom, 6-32 UNC. Max screw length into bottom of drive 0.18 in. (4.572 mm).

[3] Power and interface connections.

[4] Decorative front panel.

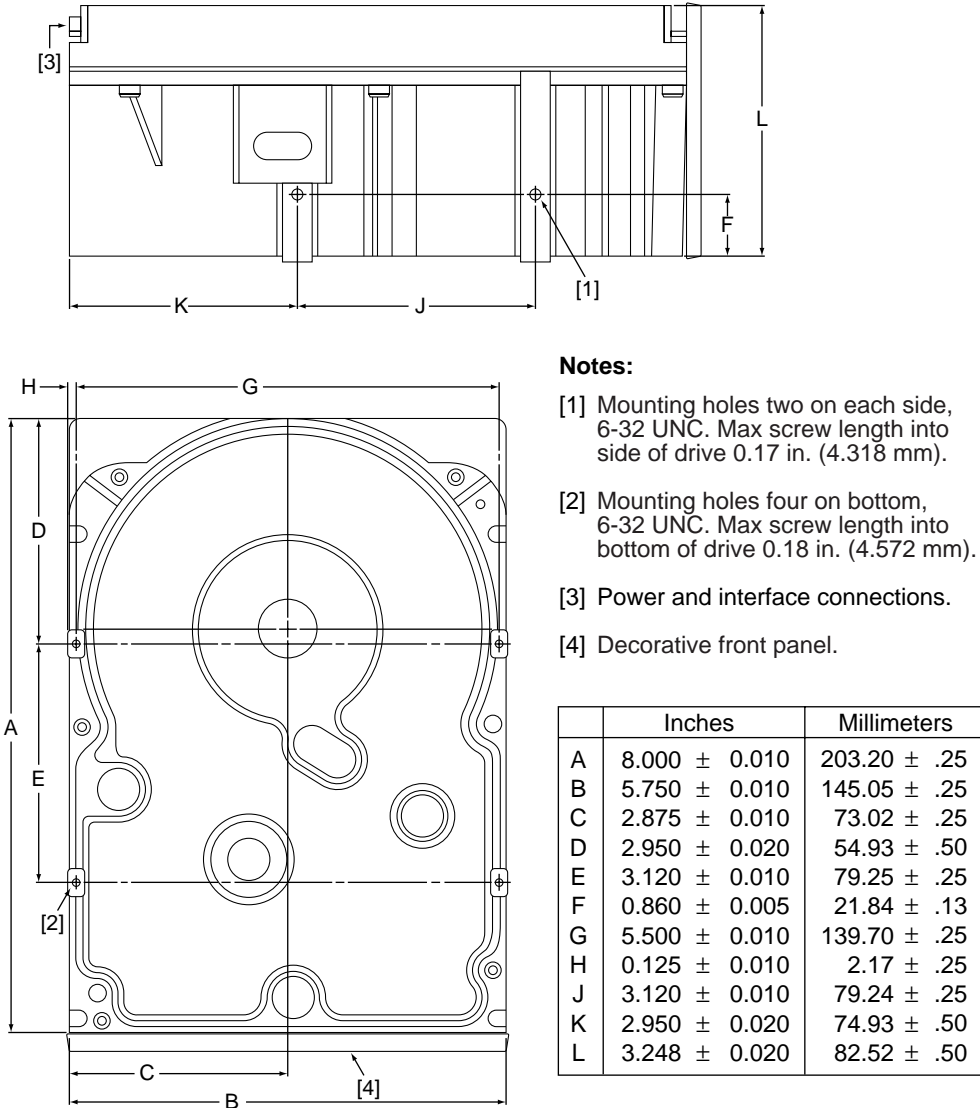|	Inches	Millimeters
A	8.000 ± 0.010	203.20 ± .25
B	5.750 ± 0.010	145.05 ± .25
C	2.875 ± 0.010	73.02 ± .25
D	2.950 ± 0.020	54.93 ± .50
E	3.120 ± 0.010	79.25 ± .25
F	0.860 ± 0.005	21.84 ± .13
G	5.500 ± 0.010	139.70 ± .25
H	0.125 ± 0.010	2.17 ± .25
J	3.120 ± 0.010	79.24 ± .25
K	2.950 ± 0.020	74.93 ± .50
L	3.248 ± 0.020	82.52 ± .50

Figure 7.   Mounting configuration dimensions for "W" and "WD" models

7.0   Defect and error management

The drive, as delivered, complies with this product manual. The read error rate and specified storage capacities are not dependent on using defect management routines by the host (initiator).

Defect and error management in the SCSI system involves the drive internal defect/error management and SCSI systems error considerations (errors in communications between initiator and the drive).

7.1   Drive internal defects and errors

During the initial drive format operation at the factory, media defects are identified, tagged as being unusable, and their locations recorded on the drive primary defects list (referred to as the "P" list and also as the EFT defect list). At factory format time, these known defects are also reallocated, that is, reassigned to a new place on the medium and the location listed in the defects reallocation table. The "P" list is not altered after factory formatting. Locations of defects found and reallocated during error recovery procedures after drive shipment are listed in the "G" list (defects growth list). The "P" and "G" lists may be referenced by the initiator using the Read Defect Data command (see Section 5.2.1.2 in the *SCSI Interface Product Manual,* part number 77738479).

7.2   Drive error recovery procedures

Whenever an error occurs during drive operation, the drive, if programmed to do so, performs error recovery procedures to attempt to recover the data. The error recovery procedures used depend on the options previously set up in the error recovery parameters mode page. Error recovery and defect management may involve the use of several SCSI commands, the details of which are described in the *SCSI Interface Product Manual.* The drive implements selectable error recovery time limits such as are required in video applications. For additional information on this, refer to Table 5.2.1-22 in the *SCSI Interface Product Manual* which describes the Mode Select/Mode Sense Error Recovery parameters.

The error recovery scheme supported by the drive provides a means to control the total error recovery time for the entire command in addition to controlling the recovery level for a single LBA. The total amount of time spent in error recovery for a command can be limited via the Recovery Time Limit bytes in the Error Recovery Mode Page. The total amount of time spent in error recovery for a single LBA can be limited via the Read Retry Count or Write Retry Count bytes in the Error Recovery Mode Page.

The drive firmware error recovery algorithms consist of 16 levels for read recoveries and 12 levels for writes. Each level may consist of multiple steps, where a step is defined as a recovery function involving a single re-read or re-write attempt. The maximum level used by the drive in LBA recovery is determined by the Read and Write Retry Counts.

Table 4 equates the Read and Write Retry Count with the maximum possible recovery time for read and write recovery of individual LBAs. The times given do not include time taken to perform reallocations, if reallocations are performed. The ARRE bit enables/disables reallocations, but if the RC bit is one, it takes precedence over ARRE to disable auto reallocation. When the drive has read all of the called for data, it does not go back and reallocate any sectors of erroneous data that were not reallocated because the RC bit was one. The drive does not report an unrecovered error when RC is one.

Table 4: **Read and write retry count maximum recovery times**

Read retry count [1]	Maximum recovery time per LBA (cumulative, msec)	Write retry count [1]	Maximum recovery time per LBA (cumulative, msec)
0	56	0	56
1	89	1	89
2	123	2	123
3	167	3	189
4	245	4	234
5	289	5	245
6	356	6	289
7	489	7	356
8	534	8	456
9	600	9	589
10	700	10	1256
11	900	11	2423
12	1178	12 (default)	3589
13	1845		
14	3012		
15	4178		
16 (default)	4378		

[1] Setting these retry counts to a value below the default setting could result in degradation of the unrecovered error rate below the product specification.

For example, suppose the read/write recovery page has the RC bit = 0, the read retry count set to 4, and the recovery time limit set to 456. A four block read command can take up to 197 msec recovery time for each block and a maximum of 456 msec recovery time for all four blocks. If either of these limits is reached and a block has not yet been recovered, the command will end with CHECK CONDITION status and an unrecoverable read error will be reported.

8.0   Installation

The first thing to do when installing a drive is to set the drive ID (select) on the SCSI bus and set up certain operating options. This is usually done by installing small shorting jumpers on the pins of connectors J01, J4A, and J4B on the PCB. Some users connect cables to the jumper headers and perform the set-up using remote switches.

If your system is "SCAM" (SCSI Configured Auto Magically) compliant, the system assigns the drive ID over the interface, so there is no need to be concerned about drive ID. Setting the drive ID jumpers doesn't hurt anything, but is not necessary.

If your system is not "SCAM" compliant, you do need to set the drive ID using the ID jumpers.

Configure drive options

For option jumper locations and definitions refer to Figures 8, 9a, and 10a. Drive default mode parameters are not normally needed for installation. Refer to Section 9.3.2 for default mode parameters if they are needed.

- Ensure that the SCSI ID of the drive is not the same as the host adapter. Most host adapters use SCSI ID 7. ID 7 is the highest priority on both 8 and 16 bit data buses.
- If multiple devices are on the bus, set the drive SCSI ID to one that is not presently used by other devices on the bus.
- If the drive is the only device on the bus, attach it to the end of the SCSI bus cable. Permanently installed terminators must be enabled on the drive for "N" and "W" models using jumper plug **TE** if termination is not provided by the host equipment. On "WD" models, external terminators must be provided by the user, systems integrator or host equipment manufacturer.
- If the drive is attached to a bus that contains other devices and the new drive is not attached to the end of the bus, the Terminator Enable jumper (**TE**) should be removed from the new drive.

Note.   For additional information about terminator requirements, refer to Sections 9.8 and 9.9.

- Set all appropriate option jumpers for desired operation prior to power on. If jumpers are changed after power has been applied, recycle the drive power to make the new settings effective.
- Installation instructions are provided by host system documentation or with any additionally purchased drive installation software. If necessary, see Section 10.0 for Seagate support services telephone numbers.
- Do not remove the manufacturer's installed labels from the drive and do not cover with additional labels, as the manufacturer labels contain information required when servicing the product.

Formatting

- It is not necessary to low level format this drive. The drive is shipped from the factory low level formatted in 512-byte sectors.
- Reformat the drive if a different spare sector allocation scheme is selected.
- High level formatting the drive involves assigning one or more partitions or logical drives to the drive volume. Follow the instructions in the system manuals for the system into which the drive is to be installed.
- Systems that have Windows 95 Operating System version 950B (this has FAT32) or later do not need to partition the drive.

8.1   Drive ID/option select header

Figures 8, 9a, and 10a show views of the drive ID select and option select jumper connectors. The notes following the figures describe the functions of the various jumper positions on the connectors J01, J4A, and J4B.
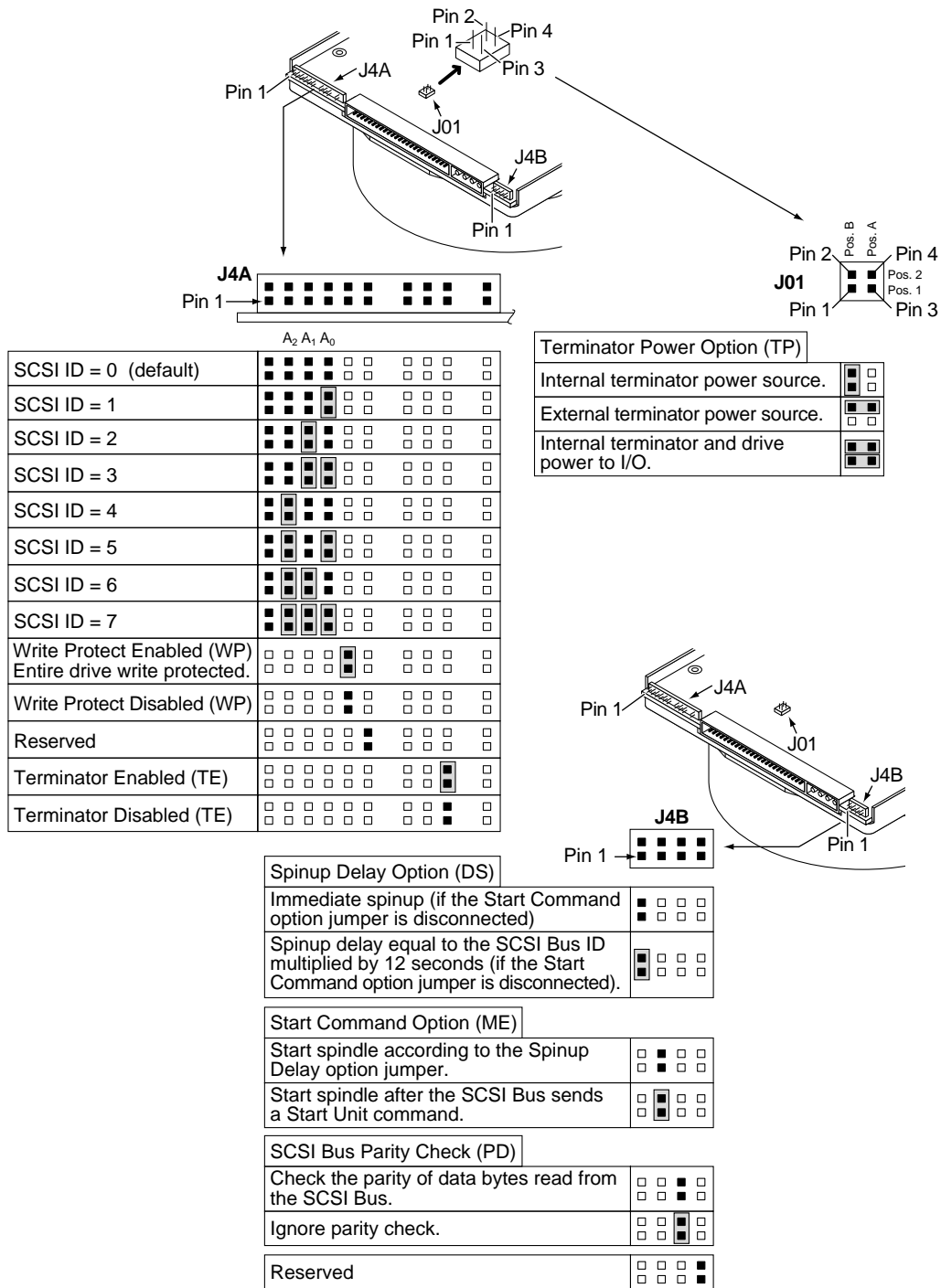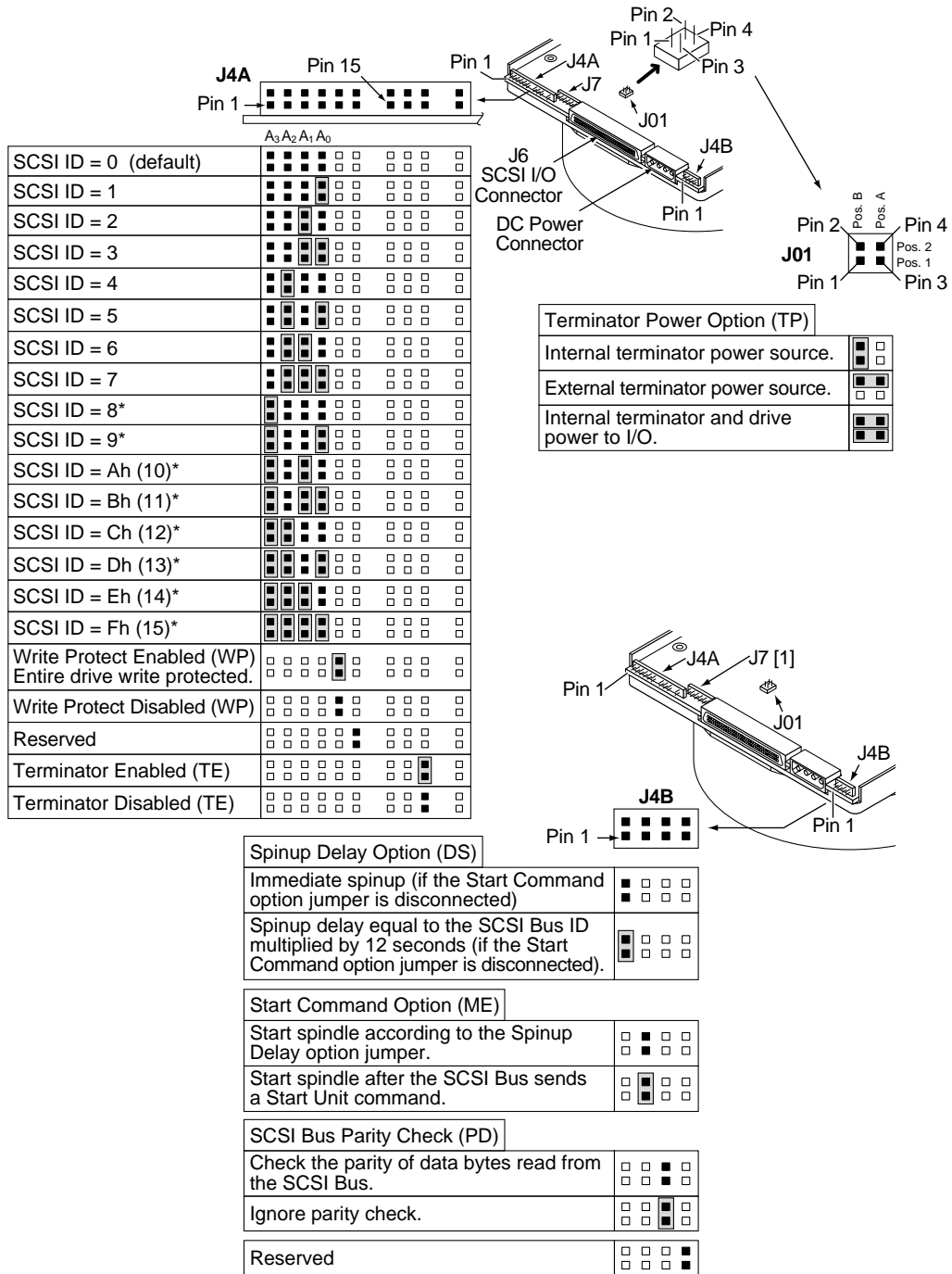
Figure 8.   **ST423451N option select jumper connectors**

J4A · Pin 15 · Pin 1 · J4A · J7 · J01 · Pin 2 · Pin 1 · Pin 4 · Pin 3

J6 SCSI I/O Connector · DC Power Connector · J4B · Pin 1

Pin 2 · Pos. B · Pos. A · Pin 4 · Pos. 2 · Pos. 1 · **J01** · Pin 1 · Pin 3

	A_3 A_2 A_1 A_0
SCSI ID = 0 (default)	
SCSI ID = 1	
SCSI ID = 2	
SCSI ID = 3	
SCSI ID = 4	
SCSI ID = 5	
SCSI ID = 6	
SCSI ID = 7	
SCSI ID = 8*	
SCSI ID = 9*	
SCSI ID = Ah (10)*	
SCSI ID = Bh (11)*	
SCSI ID = Ch (12)*	
SCSI ID = Dh (13)*	
SCSI ID = Eh (14)*	
SCSI ID = Fh (15)*	
Write Protect Enabled (WP) Entire drive write protected.	
Write Protect Disabled (WP)	
Reserved	
Terminator Enabled (TE)	
Terminator Disabled (TE)	

Terminator Power Option (TP)	
Internal terminator power source.	
External terminator power source.	
Internal terminator and drive power to I/O.	

J4A · J7 [1] · Pin 1 · J01 · J4B · Pin 1

J4B · Pin 1

Spinup Delay Option (DS)	
Immediate spinup (if the Start Command option jumper is disconnected)	
Spinup delay equal to the SCSI Bus ID multiplied by 12 seconds (if the Start Command option jumper is disconnected).	

Start Command Option (ME)	
Start spindle according to the Spinup Delay option jumper.	
Start spindle after the SCSI Bus sends a Start Unit command.	

SCSI Bus Parity Check (PD)	
Check the parity of data bytes read from the SCSI Bus.	
Ignore parity check.	
Reserved	

[1] J7 used on WD model only

Figure 9a.   ST423451W/WD option select jumper connectors

	A₃ A₂ A₁ A₀
SCSI ID = 0 (default)	
SCSI ID = 1	
SCSI ID = 2	
SCSI ID = 3	
SCSI ID = 4	
SCSI ID = 5	
SCSI ID = 6	
SCSI ID = 7	
SCSI ID = 8*	
SCSI ID = 9*	
SCSI ID = Ah (10)*	
SCSI ID = Bh (11)*	
SCSI ID = Ch (12)*	
SCSI ID = Dh (13)*	
SCSI ID = Eh (14)*	
SCSI ID = Fh (15)*	
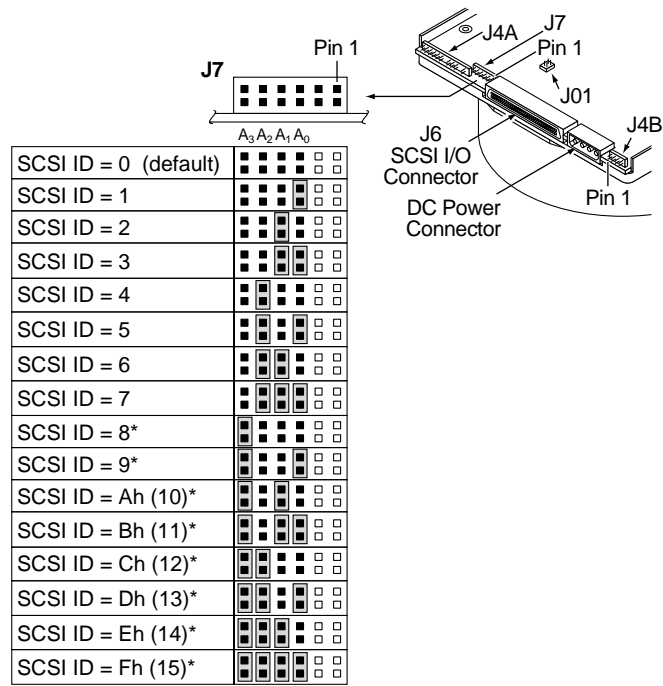
Figure 9b.   ST423451 "WD" model auxillary remote cable ID select
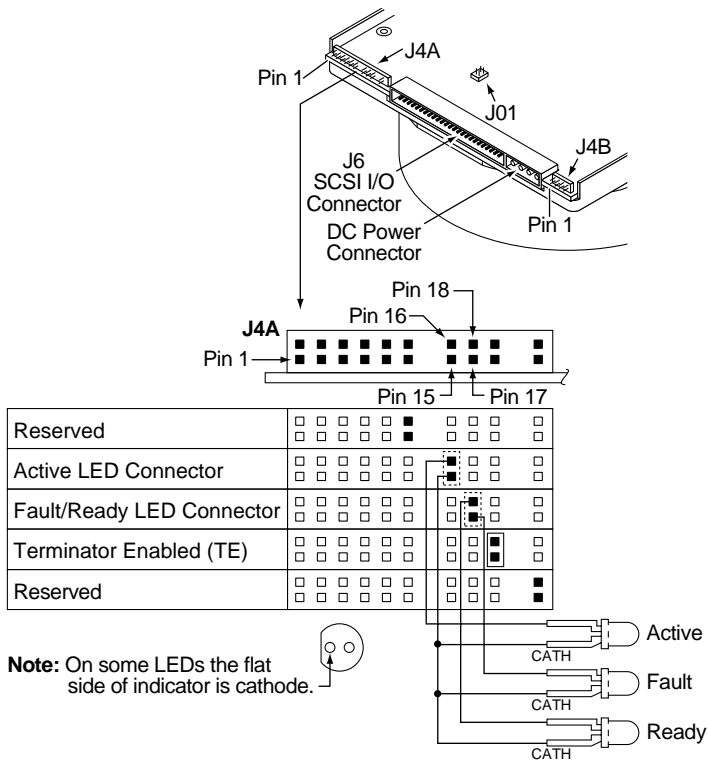
Figure 10a.   J4A connections for Activity, Fault, and Ready LED indicators for all models
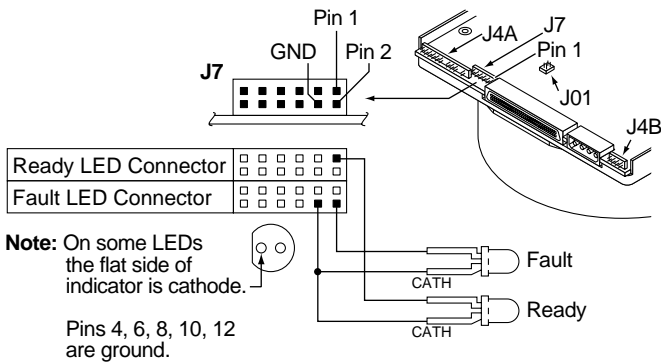
Figure 10b.   J7 auxiliary remote cable connections for Ready and Fault indicators, "WD" model only

8.1.1 Notes for Figures 8 through 10b

Notes explaining the functions of the various jumpers on jumper header connectors J01, J4A and J4B are given here. The term "**default**" means as standard OEM units are configured with a jumper on those positions when shipped from factory. "Off" means no jumper is installed; "On" means a jumper is installed. OFF or ON underlined is factory **default** condition.

Function description of configuration jumpers

J4A jumpers	Jumper function description
A_3[1]**, A_2, A_1, A_0**	SCSI ID jumpers. Drive ID address on the SCSI bus from 0 to 15 established by these jumpers as shown. **Default** is Drive ID = 0. ID = 7 is highest priority which is usually the SCSI host adapter. Priorities go ID7 to ID0, then, on "W" and "WD" model drives, ID15 to ID8.

WP	(Applies to all models)
On	Entire drive is write protected.
Off	Drive is not write protected. **(Default)**

TE	(Applies only to "N" and "W" models)
On	On-board (non-removable) terminator circuits are enabled. **(Default)**
Off	On-board (non-removable) terminator circuits are disabled.

J7 remote cable connector	Function description ("WD" model only)
A_3, A_2, A_1, A_0	SCSI ID jumpers. Drive ID address on the SCSI bus from 0 to 15 established by these jumpers as shown. **Default** is Drive ID = 0. ID = 7 is highest priority which is usually the SCSI host adapter. Priorities go ID7 to ID0, then ID15 to ID8. Pins 4, 6, 8, 10, and 12 are ground.
READY LED	Pins 1, 4 (See Figure 10b.)
FAULT LED	Pins 2, 4 (See Figure 10b.)

J4B Jumpers

DS	ME	(Applies to all models)
Off	Off	Spindle starts immediately after power up. **(Default)**
Off	On	Spindle does not start until a Start Unit command is received from the host.
On	Off	Startup is delayed by SCSI ID times 12 seconds after power is applied. For example: Drive with SCSI ID of 0 starts the spindle immediately when DC power is connected, drive with SCSI ID of 1 starts after a 12-second delay, drive with SCSI ID of 2 starts after 24-second delay, etc. Tolerance is plus 3 seconds, minus 0 seconds.
On	On	Spindle starts when the host sends a Start Unit command. Delayed start feature is over-ridden and does not apply when the **ME** jumper is installed.

PD	(Applies to all models)
On	SCSI parity checking and parity error reporting by the drive is disabled.
Off	Drive checks for parity and reports the results of parity checking to host. **(Default)**

J01 Jumpers [2]	(Applies to all models)
No jumpers on	No terminator power is connected to the drive terminators or the SCSI bus I/O cable.
2-4	Drive terminator power comes from SCSI bus.
1-3 and 2-4	Drive supplies terminator power to itself (internal connection) and to the SCSI bus I/O cable.
1-2	This horizontally-positioned jumper connects terminator power from drive's internal power to the drive's internal terminators only (for single-ended I/O only).

[1] A3 used only on "W" and "WD" drives.
[2] See Tables 12, 13, and 14 for I/O connector (J6) pins used for Termpower.

8.2   Drive orientation

The balanced rotary arm actuator design of the drive allows it to be mounted in any orientation. All drive performance characterization, however, has been done with the drive in horizontal (discs level) and vertical (drive on its side) orientations, and these are the two preferred mounting orientations.

8.3   Cooling

Cabinet cooling must ensure that the ambient temperature immediately surrounding the drive will not exceed temperature conditions specified in Section 6.4.1. Specific consideration should be given to make sure adequate air circulation is present around the printed circuit board (PCB) to meet the requirements of Section 6.4.1.

8.3.1   Air flow

The rack, cabinet, or drawer environment for the drive must provide cooling of the electronics and the head and disc assembly (HDA). You should confirm that adequate cooling is provided using the temperature measurement guidelines described below.

The drive should be oriented, or air flow directed, so that the least amount of air-flow resistance is created while providing air flow to the electronics and HDA. Also, the shortest possible path between the air inlet and exit should be chosen to minimize the travel length of air heated by the drive and other heat sources within the rack, cabinet, or drawer environment.

Possible air-flow patterns are shown in Figure 11. The air-flow patterns are created by one or more fans, either forcing or drawing air as shown in the illustrations. Other air-flow patterns are acceptable as long as the temperature measurement guidelines of Section 6.4.1 are met.
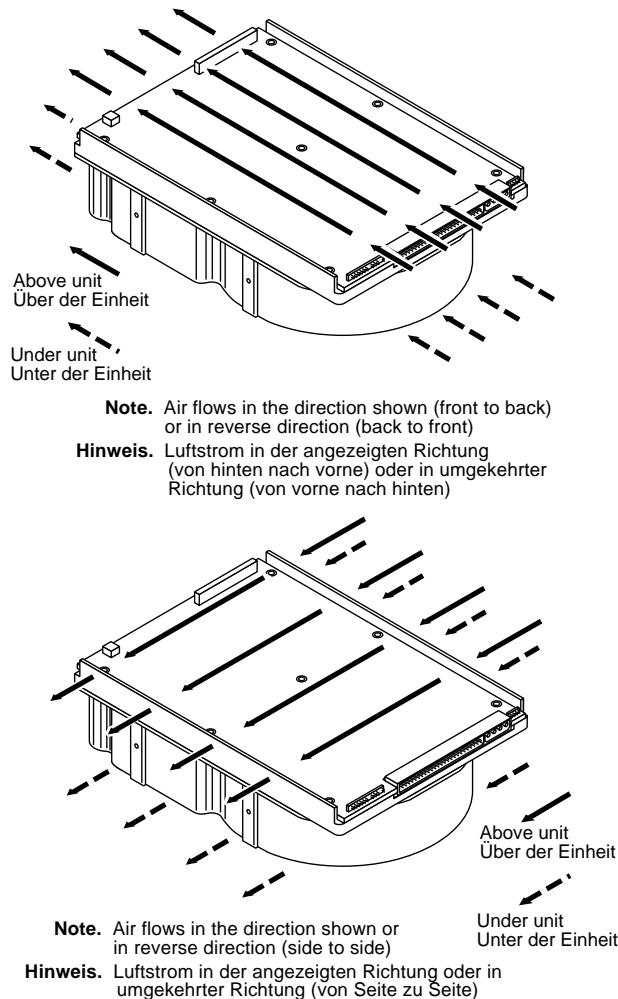

Above unit
Über der Einheit

Under unit
Unter der Einheit

Note. Air flows in the direction shown (front to back)
or in reverse direction (back to front)
Hinweis. Luftstrom in der angezeigten Richtung
(von hinten nach vorne) oder in umgekehrter
Richtung (von vorne nach hinten)

Above unit
Über der Einheit

Under unit
Unter der Einheit

Note. Air flows in the direction shown or
in reverse direction (side to side)
Hinweis. Luftstrom in der angezeigten Richtung oder in
umgekehrter Richtung (von Seite zu Seite)

Figure 11.   Suggested air flow

8.4   Drive mounting

No special drive mechanical mounting constraints are applicable to this drive.

8.5   Grounding

Signal ground (PCB) and HDA ground are connected together in the drive and cannot be separated by the user. The equipment in which the drive is mounted is connected directly to the HDA and PCB with no electrically-isolating shock mounts. If you do not want the system chassis to be connected to the HDA/PCB ground, you must provide a nonconductive (electrically-isolating) method of mounting the drive in the host equipment. Increased radiated emissions may result if you do not provide the maximum surface area ground connection between system ground and drive ground. This is the system designer's and integrator's responsibility.

9.0   Interface requirements

This section describes Elite 23 interface requirements.

9.1   General description

This section partially describes the interface requirements as implemented on the drives. The major portion of the interface requirements/implementation is described in the *SCSI Interface Product Manual*, part number 77738479. This section has tables that give the Elite 23 family drive's version of the SCSI implementation described in the *SCSI Interface Product Manual*.

9.2   SCSI interface messages supported

Table 5 lists the messages supported by the SCSI-2 and SCSI-3 modes of the Elite 23 family drives.

Table 5:   SCSI messages supported by Elite 23 family drives

Message Name	Message Code	Supported by SCSI-2
Abort	06h	Y
Abort-tag	0Dh	Y
Bus device reset	0Ch	Y
Clear queue	0Eh	Y
Command complete	00h	Y
Continue I/O process	12h	Y
Disconnect	04h	Y
Extended messages	01h[1]	Y
Identify	80h-FFh	Y
Ignore wide residue (two bytes)	23h	N
Initiate recovery	0Fh	N
Initiator detected error	05h	Y
Linked command complete	0Ah	Y
Linked command complete with flag	0Bh	Y
Message parity error	09h	Y
Message reject	07h	Y
Modify data pointer	[1]	N
No operation	08h	Y
Queue tag messages (two bytes)		
Head of queue tag	21h	Y
Ordered queue tag	22h	Y
Simple queue tag	20h	Y
Release recovery	10h	N
Restore pointers	03h	Y
Save data pointer	02h	Y
Synchronous data transfer req.	[1]	Y
Target transfer disable	13h	Y
Terminate I/O process	11h	Y
Wide data transfer request	[1] [2]	Y

Notes.

[1]   Extended message (refer to the *SCSI Interface Product Manual*, part number 77738479).
[2]   Not applicable to "N" models.

9.3 SCSI interface commands supported

Table 6 lists the SCSI interface commands that are supported in the SCSI-2 and SCSI-3 modes of the drive. OEM standard drives are shipped set to operate in SCSI-2/SCSI-3 mode. Elite family drives can be changed back and forth between SCSI-1, SCSI-2, and SCSI-3 modes using the Change Definition command.

Table 6:   Commands supported by Elite 23 family drive

Command Name	Command Code	Supported by SCSI-2/3
Change definition	40h	Y
Compare	39h	N
Copy	18h	N
Copy and verify	3Ah	N
Format unit [1]	04h	Y
Block format		N
Bytes from index		Y
Physical sector format		Y
DPRY bit supported		Y
DCRT bit supported		Y
STPF bit supported		Y
IP bit supported		Y
DSP bit supported		Y
IMMED bit supported		Y
VS		N
Inquiry	12h	Y
Date code page (C1h)		Y
Device behavior page (C3h)		Y
Firmware numbers page (C0h)		Y
Implemented operating definitions page (81h)		Y
Jumper settings page (C2h)		Y
Supported vital product data pages (0h)		Y
Unit serial number page (80h)		Y
Lock-unlock cache	36h	N
Log select	4Ch	Y
DU bit		N
DS bit		Y
TSD bit		Y
ETC bit		N
TMC bit		N
LP bit		N
Log sense	4Dh	Y
Cache statistics page (37h)		Y
Non-medium error page (06h)		Y
Pages supported list (00h)		Y
Power-on time page (3Eh)		Y
Read error counter page (03h)		Y
S.M.A.R.T. status log page (2Fh)		N
S.M.A.R.T. attitude log page (30h)		N
Verify error counter page (05h)		Y
Write error counter page (02h)		Y

Table 6: **Commands supported by Elite 23 family drive (continued)**

Command Name	Command Code	Supported by SCSI-2/3
Mode select (same pages as Mode Sense command, see below)	15h	Y [2] [3]
Mode select (10)	55h	Y
Mode sense	1Ah	Y [2] [3]
Caching parameters page (08h)		Y
Control mode page (0Ah)		Y
Disconnect/reconnect (02h)		Y
Error recovery page (01h)		Y
Format page (03h)		Y
Information exceptions control page (1Ch)		Y
Notch and partition page (0C)		Y
Power condition page (1Ah)		Y
Rigid disc drive geometry page (04h)		Y
Unit attention page (00h)		Y
Verify error recovery page (07h)		Y
Xor control page (10h)		Y
Mode sense (10)	5Ah	Y
Prefetch	34h	N
Read	08h	Y
Read buffer (modes 0, 2, 3 supported)	3Ch	Y
Read capacity	25h	Y
Read defect data	37h	Y
Read extended	28h	Y
DPO bit supported		Y
FUA bit supported		Y
Read long	3Eh	Y
Reassign blocks	07h	Y
Rebuild	81h	N
Receive diagnostic results	1Ch	Y
Supported diagnostics pages (00h)		Y
Translate page (40h)		Y
Regenerate	82h	N
Release	17h	Y
Release (10)	57h	Y
Request sense	03h	Y
Actual retry count bytes		Y
Deferred error supported		Y
Extended sense		Y
Field pointer bytes		Y
Reserve	16h	Y
3rd party reserve		Y
Extent reservation		N
Reserve (10)	56h	Y
3rd party reserve		Y
Extent reservation		N
Rezero unit	01h	Y

Table 6:   Commands supported by Elite 23 family drive (continued)

Command Name	Command Code	Supported by SCSI-2/3
Search data equal	31h	N
Search data high	30h	N
Search data low	32h	N
Seek	0Bh	Y
Seek extended	2Bh	Y
Send diagnostics page	1Dh	Y
Supported diagnostics pages		Y
Translate page		Y
Set limits	33h	N
Start unit/stop unit (start/stop spindle)	1Bh	Y
Synchronize cache	35h	Y
Test unit ready	00h	Y
Verify	2Fh	Y
DPO bit supported		Y
BYTCHK bit supported		Y
Write	0Ah	Y
Write and verify	2Eh	Y
DPO bit supported		Y
BYTCHK bit supported		Y
Write buffer (modes 0, 2 supported)	3Bh	Y
Firmware download option (modes 5, 7 supported) [4]		Y
Write extended	2Ah	Y
DPO bit supported		Y
FUA bit supported		Y
Write long	3Fh	Y
Write same	41h	Y
XD read	52h	Y
XD write	50h	Y
XD write extended	80h	N
XP write	51h	Y

[1] The drive can format to any even number of bytes per sector from 512 to 4,096.
[2] Supports 6-byte and 10-byte versions.
[3] Table 8 shows how individual bits are set which are changeable by the host.
[4] **Warning:** A power loss during flash programming can result in firmware corruption. This usually makes the drive inoperable.

9.3.1 Inquiry data

Table 7 following lists the Standard Inquiry command data that the drive returns to the initiator per the format given in the *SCSI Interface Product Manual,* part number 77738479, section 5.1.1.3.

Table 7:   Elite 23 family drive Standard Inquiry data

Bytes	Data (HEX)																
0-15	00	00	[02][1]	[02][2]	8B	00	[00][6]	[1E][3]	53	45	41	47	41	54	45	20	VENDOR ID
16-31	53	54	[34]	[32]	[33]	[34]	[35]	[31]	[4E][4]	20	20	20	20	20	20	20	PRODUCT ID
32-47	R#	R#	R#	R#	S#	S#	S#	S#	S#	S#	S#	S#	00	00	00	00	
48-63	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
64-79	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
80-95	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
96-111	00	43	6F	70	79	72	69	67	68	74	20	28	63	29	20	[31]	COPYRIGHT
112-127	[39]	[39]	[36][5]	20	53	65	61	67	61	74	65	20	41	6C	6C	20	NOTICE
128-143	72	69	67	68	74	73	20	72	65	73	65	72	76	65	64	20	

Notes.

[ ][1]   The drive can be changed between these two configurations:
01 = SCSI-1 implemented.
02 = SCSI-2/SCSI-3 implemented (default is 02).

[ ][2]   The drive can be changed between these two configurations:
01 = Response data is in SCSI-1 format and has compatibility with Common Command Set data.
02 = Response data is in SCSI-2/SCSI-3 format (default).

[ ][3]   For "N" models, this value is 1E.
For "W" and "WD" models, this value is 3E.

R#   Four ASCII digits representing the last four digits of the product Firmware Release number. This information is also given in the Vital Product Data page C0h, together with servo RAM and ROM release numbers.

S#   Eight ASCII digits representing the eight digits of the product serial number.

[ ][4]   Bytes 18 through 23 reflect model of drive. Shown here are hex values for Model ST423451N.

For models "W" and "WD," byte 24 is 57 (W), since these are wide data bus drives and that is the only fact the host needs to discover from byte 23.

[ ][5]   Copyright Year - changes with actual year.

[ ][6]   For "N" models, this value is 00. For models "W" and "WD," this value is 01.

9.3.1.1 Inquiry Vital Product Data pages

Instead of the Standard Inquiry data shown in Table 7, the initiator can request several Vital Product Data pages by setting the Inquiry command EVPD bit to one. The *SCSI Interface Product Manual,* part number 77738479, section 5.1.1.3.1 lists the Vital Product Data pages supported and describes their formats. A separate Inquiry command must be sent to the drive for each Vital Product Data page the initiator wants the drive to send back.

9.3.2 Mode Sense data

The Mode Sense command provides a means for the drive to report its operating parameters to the initiator. The drive maintains four sets of mode parameters: default values, saved values, current values and changeable values.

Default values are hard-coded in the drive firmware that is stored in flash EPROM nonvolatile memory on the drive PCB. Default values can be changed only by downloading a complete set of new firmware into the flash EPROM. An initiator can request and receive from the drive a list of default values and use those in a Mode Select command to set up new current and saved values, where the values are changeable.

Saved values are stored on the disk media using a Mode Select command. Only parameter values that are allowed to be changed can be changed by this method. "Changeable values" are defined below. Parameters in the saved values list that are not changeable by the Mode Select command get their values from the default values storage.

Current values are volatile values currently being used by the drive to control its operation. A Mode Select command can be used to change these values (only those that are changeable). Originally, they are installed from saved or default values after a power on reset, hard reset, or Bus Device Reset message.

Changeable values form a bit mask, stored in nonvolatile memory, that dictates which of the current values and saved values can be changed by a Mode Select command. A "one" allows a change to a corresponding bit; a "zero" allows no change. For example, in Table 8 refer to Mode page 01, in the first row titled "CHG." These are hex numbers representing the changeable values for Mode page 01. Note in columns 1 and 2 (bytes 00 and 01), there is 00h, which indicates that in bytes 00 and 01 none of the bits are changeable. Note also that bytes 04, 05, 06, and 07 are not changeable, because those fields are all zeros. In byte 02, hex value EF equates to the binary pattern 1110 1111. If there were a zero in any bit position in the field, it means that bit is not changeable. Bits 7, 6, 5, 3, 2, 1, and 0 are changeable, because those bits are all ones. Bit 4 is not changeable. In this particular example, it indicates 7 of 8 error recovery control bits are changeable. FF in column 4 indicates all bits in byte 3 are changeable.

The changeable values list can only be changed by downloading new firmware into the flash EPROM.

On drives requiring unique saved values, the required unique saved values are stored into the saved values storage location on the media prior to shipping the drive. Some drives may have unique firmware with unique default values also.

On standard OEM drives the saved values are taken from the default values list and stored into the saved values storage location on the media prior to shipping.

When a drive is powered up, it takes saved values from the media and stores them to the current values storage in volatile memory. It is not possible to change the current values (or the saved values) with a Mode Select command before the drive is up to speed and is "ready." An attempt to do so results in a "Check Condition" status being returned.

Note. Because there may be several different versions of drive control firmware in the total population of drives in the field, the Mode Sense values given in the following tables may not exactly match those of some drives.

The following tables list the values of the data bytes returned by the drive in response to the Mode Sense command pages (see *SCSI Interface Product Manual,* part number 77738479).

Definitions:

SAV = Saved values are stored on the disk media using a Mode Sense command.
DEF = Default value; standard drives are shipped configured this way.
CHG= Changeable bits; indicates if current and saved values are changeable.

Table 8: Mode Sense data, ST423451 default values (SCSI-2/3 implementation)

Bytes	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Mode Sense Data	B7	00	10	08	02	B3	91	94	00	00	02	00												
Mode Page			<--------------------------Mode page headers and parameter data bytes-------------------------->																				
SAV 01	81	0A	CC	4F	30	00	00	00	2B	00	FF	FF												
DEF 01	81	0A	CC	4F	30	00	00	00	2B	00	FF	FF												
CHG 01	81	0A	EF	FF	00	00	00	00	FF	00	00	00												
SAV 02	82	0E	80	80	00	0A	00	00	00	00	00	00	00	00	00	00								
DEF 02	82	0E	80	80	00	0A	00	00	00	00	00	00	00	00	00	00								
CHG 02	82	0E	FF	FF	00	00	00	00	00	00	00	00	87	00	00	00								
SAV 03	83	16	00	A8	00	52	00	00	00	00	00	EB	02	00	00	01	00	14	00	41	40	00	00	00
DEF 03	83	16	00	A8	00	52	00	00	00	00	02	EB	02	00	00	01	00	14	00	41	40	00	00	00
CHG 03	83	16	FF	00	FF	FF	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
SAV 04	84	16	00	1A	DC	1C	00	00	00	00	00	00	00	00	00	00	00	00	00	00	15	18	00	00
DEF 04	84	16	00	1A	DC	1C	00	00	00	00	00	00	00	00	00	00	00	00	00	00	15	18	00	00
CHG 04	84	16	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
SAV 07	87	0A	00	4F	30	00	00	00	00	00	FF	FF												
DEF 07	87	0A	00	4F	30	00	00	00	00	00	FF	FF												
CHG 07	87	0A	0F	FF	00	00	00	00	00	00	00	00												
SAV 08	88	12	10	00	FF	FF	00	00	FF	FF	FF	FF	80	03	00	00	00	00	00	00				
DEF 08	88	12	10	00	FF	FF	00	00	FF	FF	FF	FF	80	03	00	00	00	00	00	00				
CHG 08	88	12	B5	00	00	00	FF	FF	FF	FF	00	00	A0[1]	FF	00	00	00	00	00	00				
SAV 0A	8A	0A	02	00	00	00	00	00	00	00	00	00												
DEF 0A	8A	0A	02	00	00	00	00	00	00	00	00	00												
CHG 0A	8A	0A	03	F3	00	00	00	00	00	00	00	00												
SAV 10	90	16	00	00	00	00	04	CD	00	00	00	00	00	00	00	00	00	00	00	00	00	00	40	00
DEF 10	90	16	00	00	00	00	04	CD	00	00	00	00	00	00	00	00	00	00	00	00	00	00	40	00
CHG 10	90	16	02	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00

Bytes	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
SAV 1A	9A	0A	00	00	00	00	00	01	00	00	00	04												
DEF 1A	9A	0A	00	00	00	00	00	01	00	00	00	04												
CHG 1A	9A	0A	00	03	00	00	00	00	00	00	00	00												
SAV 1C	9C	0A	00	04	00	00	00	00	00	00	00	01												
DEF 1C	9C	0A	00	04	00	00	00	00	00	00	00	01												
CHG 1C	9C	0A	8C	0F	00	00	00	00	00	00	00	00												
SAV 00	80	02	00	00																				
DEF 00	80	02	00	00																				
CHG 00	80	02	77	02																				
Read Capacity Data	02	B3	91	93	00	00	02	00																

[1]   Though byte 12, bit 7 is shown as changeable, the FSW function governed by that bit is not implemented by this drive.

9.4   SCSI bus conditions and miscellaneous features supported

Asynchronous SCSI bus conditions supported by the drive are listed below. These conditions cause the SCSI device to perform certain actions and can alter the SCSI bus phase sequence. Other miscellaneous operating features supported are also listed here. Refer to the *SCSI Interface Product Manual,* part number 77738479 for details.

Table 9:   SCSI bus conditions and other miscellaneous features

ASA II	Conditions or feature
N	Adaptive caching
Y	Arbitrating system
Y	Asynchronous data transfer
Y	Asynchronous event notification
Y	Attention condition
Y	Contingent allegiance condition
Y	Capacity programming
Y	Deferred error handling
Y	Differential interface circuits available
Y	Disconnect/reconnect
Y	Flag and link bits in control byte supported
Y	Format progress indication
Y	Immediate status on format unit command
Y	Immediate status on start/stop command
Y	Immediate status on synchronize cache command
Y	Parameter rounding (controlled by the round bit in the Mode Select Page 0)
Y	Queue tagging (up to 64 queue tags supported)
Y	Reporting actual retry count in extended sense bytes 15, 16 and 17
Y	Reset condition
Y	Segmented caching
Y	SMP = 1 in Mode Select command needed to save RPL and rotational offset bytes (in Table 5.2.1-25 of the *SCSI Interface Product Manual)*
Y	Synchronous cache command
Y	Synchronous data transfer
N	Synchronized (locked) spindle operation
N	Zero latency read

ASA II	Status supported
Y	Good
Y	Check condition
Y	Condition met/good
Y	Busy
Y	Intermediate/good
Y	Intermediate/condition met/good
Y	Reservation conflict
Y	Queue full

9.5   Synchronous data transfer

The data transfer period to be used by the drive and the initiator is established by an exchange of messages during the Message Phase of operation. See the section on message protocol in the *SCSI Interface Product Manual.*

9.5.1   Synchronous data transfer periods supported

Table 10 lists synchronous data transfer periods supported by the drive.

Table 10:   Synchronous data transfer periods supported

M (Decimal)	Transfer period (M times 4 nanoseconds)	Transfer rate (mega transfers/second)
12 [1]	50 [1]	20.0 [1]
15 [1]	62.5 [1]	16.0 [1]
18 [1]	75 [1]	13.33 [1]
25	100	10.0
31	125	8.0
37	150	6.66
50	200	5.0
62	250	4.0
75	300	3.33
87	350	2.86
100	400	2.5

[1]   Fast-20 (Ultra SCSI) transfer rates.

9.5.2   REQ/ACK offset

The maximum REQ/ACK value supported by Elite 23 SCSI drives is 15 (0Fh).

9.6   Physical interface

Figures 12 and 13 show the locations of the drive physical interface components. The locations of the DC power connector, the SCSI interface connector, and the drive select and option select headers are shown.

Details of the physical, electrical and logical characteristics are given in sections following, while the SCSI operational aspects of Seagate drive interfaces are provided in the *SCSI Interface Product Manual,* part number 77738479.

This section describes the connectors, cables, signals, terminators and bus timing of the DC and SCSI I/O interface. See Sections 9.8 and 9.9 for additional terminator information.

9.6.1   DC cable and connector

The drive receives DC power through a 4-pin connector (see Figure 12 for pin assignments) mounted at the rear of the main PCB. Recommended part numbers of the mating DC power connector are listed below, but equivalent parts may be used.

Type of Cable	Connector	Contacts (20-14 AWG)
14 AWG	AMP 1-480424-0	AMP 60619-4 (loose piece)
		AMP 61117-4 (strip)

Pin	Power
1	+12V
2	+12V ret
3	+ 5V ret
4	+ 5V

J6

DC Power
Connector

Pin 1

J6
SCSI I/O
Connector

Pin 1
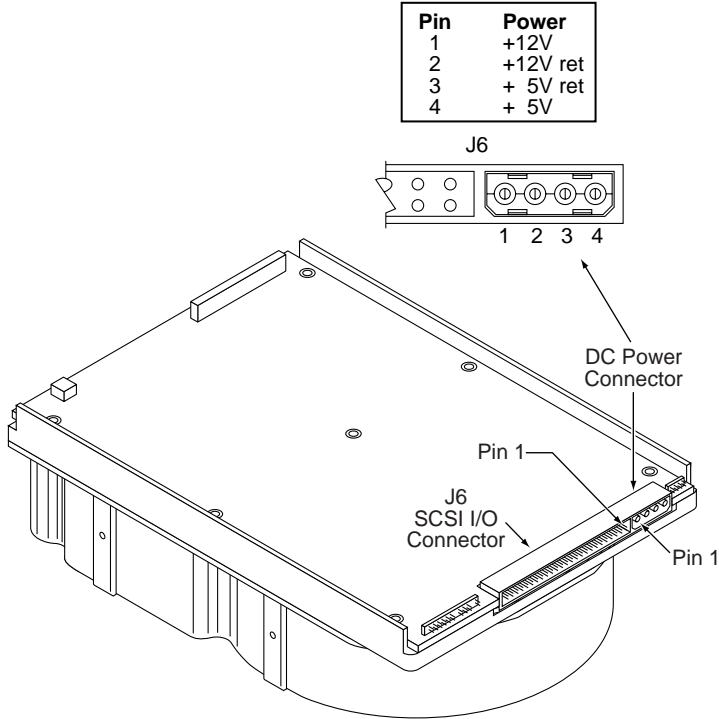
Figure 12.   Physical interface for "N" model drives

Pin	Power
1	+12V
2	+12V ret
3	+ 5V ret
4	+ 5V

J6
Pin 1

J15 DC Power

1   2   3   4

DC Power
Connector

Pin 1

J6
SCSI I/O
Connector

Pin 1
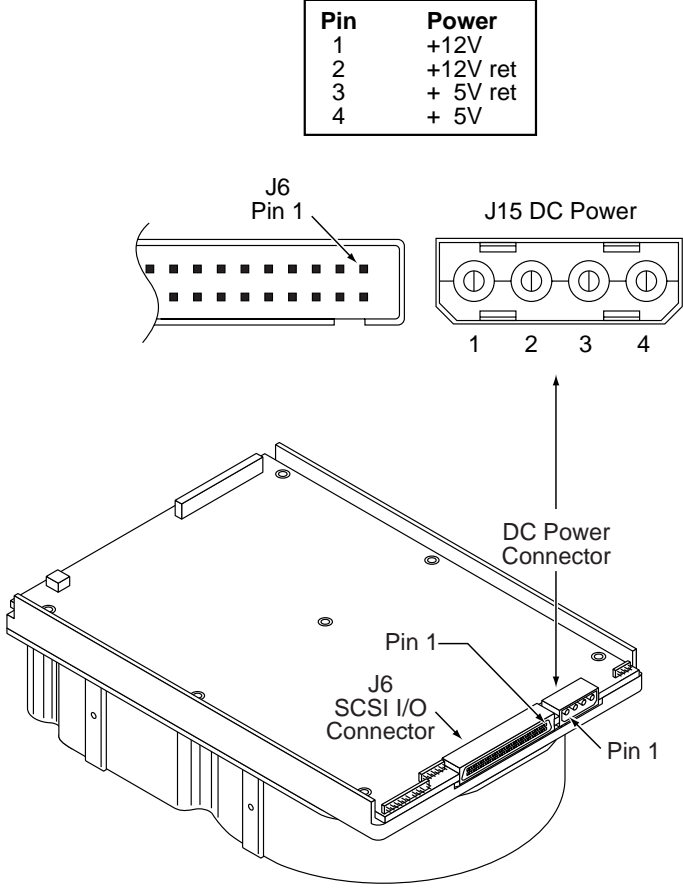
Figure 13.   Physical interface for "W" and "WD" model drives

9.6.2   SCSI interface physical description

The drives may be daisy-chained together or with other compatible SCSI devices. Both ends of the cable must be terminated. The "N" and "W" model drives implement single-ended drivers and receivers. All signals are common between all SCSI devices. The drive may be daisy-chained only with SCSI devices having the same type drivers and receivers. Devices having single-ended interface circuits cannot be on the same daisy chain with devices having differential interface circuits. A maximum of 8 ("N" models) or 16 ("W" or "WD" models) SCSI devices (including the host) may be daisy-chained together. However, please note the restrictions described in Section 9.6.3 about the number of devices allowed in a daisy chain. The SCSI devices at both ends of the daisy chain are to be terminated. Intermediate SCSI devices shall not be terminated (see Figure 14). Remove the terminator enable jumper **TE** on J4A select header ("N" and "W" models), or the external terminators ("WD" models), not the terminator power source selector jumper **TP** on J01 (Figures 8 and 9a).

9.6.3   SCSI interface cable requirements

In general, cables having the characteristic impedances given in Section 9.6.3.1 are not available; however, impedances that are somewhat lower are satisfactory. A characteristic impedance as shown in Table 10 is recommended for unshielded flat or twisted pair ribbon cable. However, most available cables have a somewhat lower characteristic impedance. To minimize discontinuances and signal reflections, cables of different impedances should not be used in the same bus. Implementations may require trade-offs in shielding effectiveness, cable length, the number of loads, transfer rates, and cost to achieve satisfactory system operation. If you mix shielded and unshielded cables within the same SCSI bus, the effect of impedance mismatch must be carefully considered. Proper impedance matching is especially important to maintain adequate margin at FAST and FAST-20 (Ultra SCSI) transfer rates.

"N" models use non-shielded cable connectors. Use a 50-conductor flat cable or 25 twisted pair cable. Use a minimum conductor size of 28 AWG to minimize noise effects.

Suggested non-shielded flat cable part numbers are:
Flat cable - 35M-3365-50   Twisted pair - Spectra Twist in flat 455-248-50

"W" and "WD" models use non-shielded cable connectors. Use a 68-conductor flat cable or 34 twisted pair cable with connectors listed in 9.6.4.2. Use a minimum conductor size of 28 AWG to minimize noise effects.

Suggested non-shielded flat cable part numbers are:
Flat cable - 35M-3365-68   Twisted pair - Spectra Twist in flat 455-248-68

9.6.3.1   Single-ended I/O circuits ("N" and "W" models)

The maximum total cable length allowed with drives having single-ended I/O driver and receiver circuits depends on several factors. Table 11 lists the maximum lengths allowed for different configurations of drive usage. These values are from the ANSI SCSI-3 Fast-20 (also called Ultra SCSI) specification X3T10/1071D. All device I/O lines must have equal to or less than 25 pf capacitance to ground, measured at the beginning of the stub.

Table 11:   Cable characteristics for single-ended circuits

I/O transfer rate	Maximum number of devices on line	Maximum cable length allowed	Transmission line impedance	
			REQ/ACK	**Other signals**
≤10 M transfers/s	8 (reg. SCSI bus)	6 meters (19.7 ft.)	90 ± 6 Ohms	90 ± 10 Ohms
≤10 M transfers/s	16 (wide SCSI bus)	6 meters (19.7 ft.)	90 ± 6 Ohms	90 ± 10 Ohms
≤20 M transfers/s	4 (reg./wide SCSI bus)	3 meters (9.8 ft.)	90 ± 6 Ohms	90 ± 10 Ohms
≤20 M transfers/s	8 (reg./wide SCSI bus)	1.5 meters (4.9 ft.) [1]	90 ± 6 Ohms	90 ± 10 Ohms

Notes:

[1]   The spacing of devices on the mainline SCSI bus should be at least three times the stub length (defined below) to avoid clustering (Refer to Annex C of X3T10/1071D). Based on this criteria, it may be that 8 devices will not actually work on 1.5 meters of line (.1 x 3 x 7 = 2.1 meters).

A stub length of no more than 0.1 meter (0.33 foot) is allowed off the mainline interconnection with any connected equipment. The stub length is measured from the transceiver to the connection to the mainline SCSI bus.

Single-ended I/O pin assignments are shown in Tables 12 and 13.

9.6.3.2   Differential I/O circuits ("WD" models)

The maximum total cable length allowed with drives having differential I/O driver and receiver circuits is 25 meters (82 feet). Twisted-pair cable (either twisted-flat or discreet wire twisted pairs) should be used with differential I/O transceiver circuits. A stub length of no more than 0.2 meter (0.66 foot) is allowed off the mainline interconnection with any connected equipment. The stub length is measured from the transceiver to the connection to the mainline SCSI bus. The spacing of devices on the mainline SCSI bus should be at least three times the stub length to avoid clustering (Refer to Annex C of X3T10/1071D). This restriction easily allows the 16 device IDs that the SCSI 16 bit wide bus can address. These values are from the ANSI SCSI-3 Fast-20 (also called Ultra SCSI) specification X3T10/1071D.

An ideal impedance match with cable terminators implies a cable characteristic impedance of 122 ohms. Differential I/O pin assignments are shown in Table 14.

9.6.4   Mating connectors

Part numbers for connectors that mate with the various Elite 23 I/O connectors are given in the sections following.

9.6.4.1   Mating connectors for ST423451N model

Use a non-shielded 50-conductor cable connector consisting of two rows of 25 female contacts with adjacent centers .100 inch apart.

Recommended mating flat cable connector part numbers are:

3M-3425-7000	W/O Strain Relief, No Center Key	Closed-end
3M-3425-7050	With Strain Relief, No Center Key	(for cable ends) [1]
Berg-66900-290	With Strain Relief, With Center Key	
3M-3425-6000	W/O Strain Relief, No Center Key	Open-end
3M-3425-6050	With Strain Relief, No Center Key	(in daisy-chain) [1]
Berg-66900-250	With Strain Relief, With Center Key	

[1]   See Figure 14.

The drive device connector is a non-shielded 50-conductor connector consisting of two rows of 25 male pins with adjacent pins .100 inch apart. The connector is keyed (see Figure 15). Mating panel mount connector: 3M-CHE-2050-J01A10-KLE.

9.6.4.2   Mating connectors for ST423451W and ST423451WD models

Use a non-shielded 68-conductor cable connector consisting of two rows of 34 male contacts with adjacent contacts 0.050 inch (1.27 mm) apart.

Recommended mating wide connector part numbers are:

Amp Model 786096-7	Female, 68-pin, panel mount
Amp Model 786090-7	Female, 68-pin, cable mount
Amp Model 749925-5	(.050 inch conductor centers, 28 or 30 AWG wire) Use two, 34 conductor, .050 inch center flat cable with this connector. This type connector can only be used on cable ends. [1]
Amp Model 88-5870-294-5	W/O Strain Relief (.025 inch conductor centers, 30 AWG wire). Use either on cable ends or in cable middle section for daisy-chain installations. [1]
Amp Model 1-480420-0	Power connector 4 circuit housing
Berg 69307-012	12-position, 2 x 6, 2 mm receptacle housing

[1]   See Figure 14.

The drive device connector is a non-shielded 68-conductor connector consisting of two rows of 34 female pins with adjacent pins .050 inch apart. The connector is keyed by means of its shape (see Figure 16).
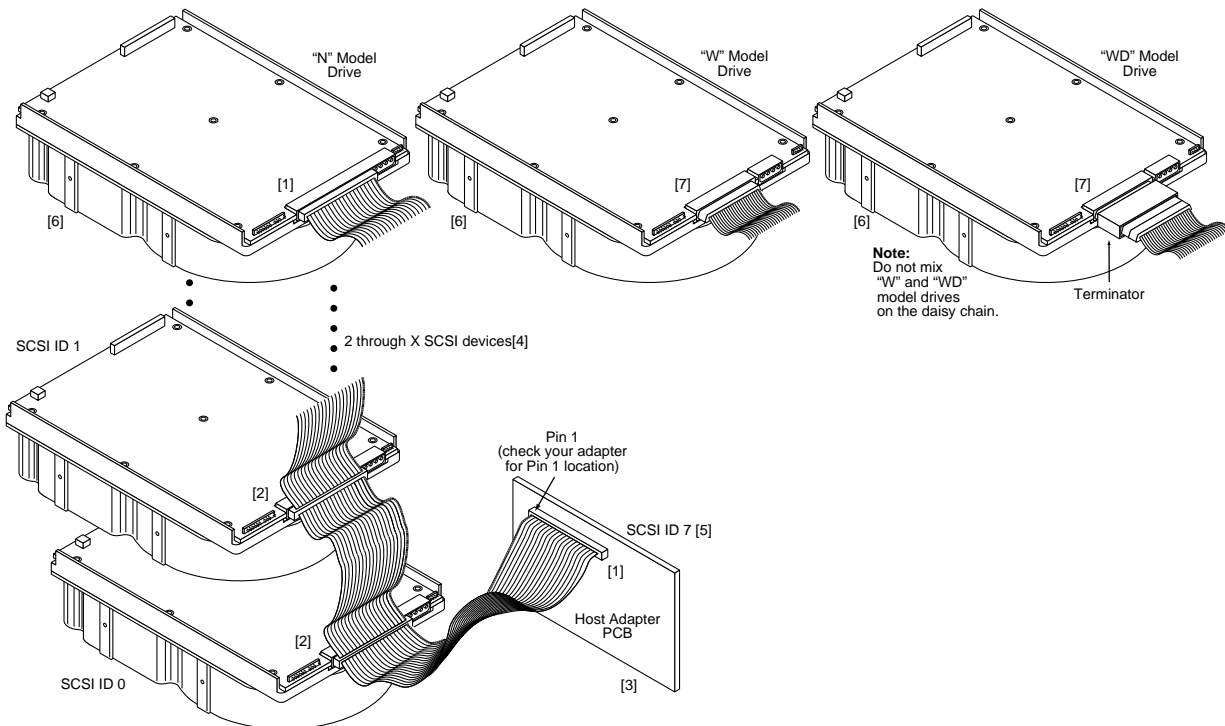
[1] Closed-end type 50-pin connector used. Install terminator enable **(TE)** jumper plug.
[2] Open-end type (in-line application) connector used. Terminators disabled.
[3] Host need not be on the end of the daisy chain. Another device can be on the end with the terminator, the host having no terminator.
[4] Total interface cable length must not exceed that specified in Section 9.6.3.1 (including host adapter/initiator). The number of devices allowed depends on data transfer rate. See Table 11.
[5] SCSI ID7 has highest arbitration priority, ID0 has lowest for "N" models. For "W" models, priority is ID 7 to ID 0, then ID 15 to ID 8. (ID 8 very lowest).
[6] Last drive on daisy chain.
[7] Open-end type 68-pin connector used. Terminators disabled. If end device, external terminator and closed-end type 68-pin connector used. On "W" models, install terminator enable **(TE)** jumper plug. "N" and "W" models do not use external terminators.

Figure 14.   SCSI daisy-chain interface cabling
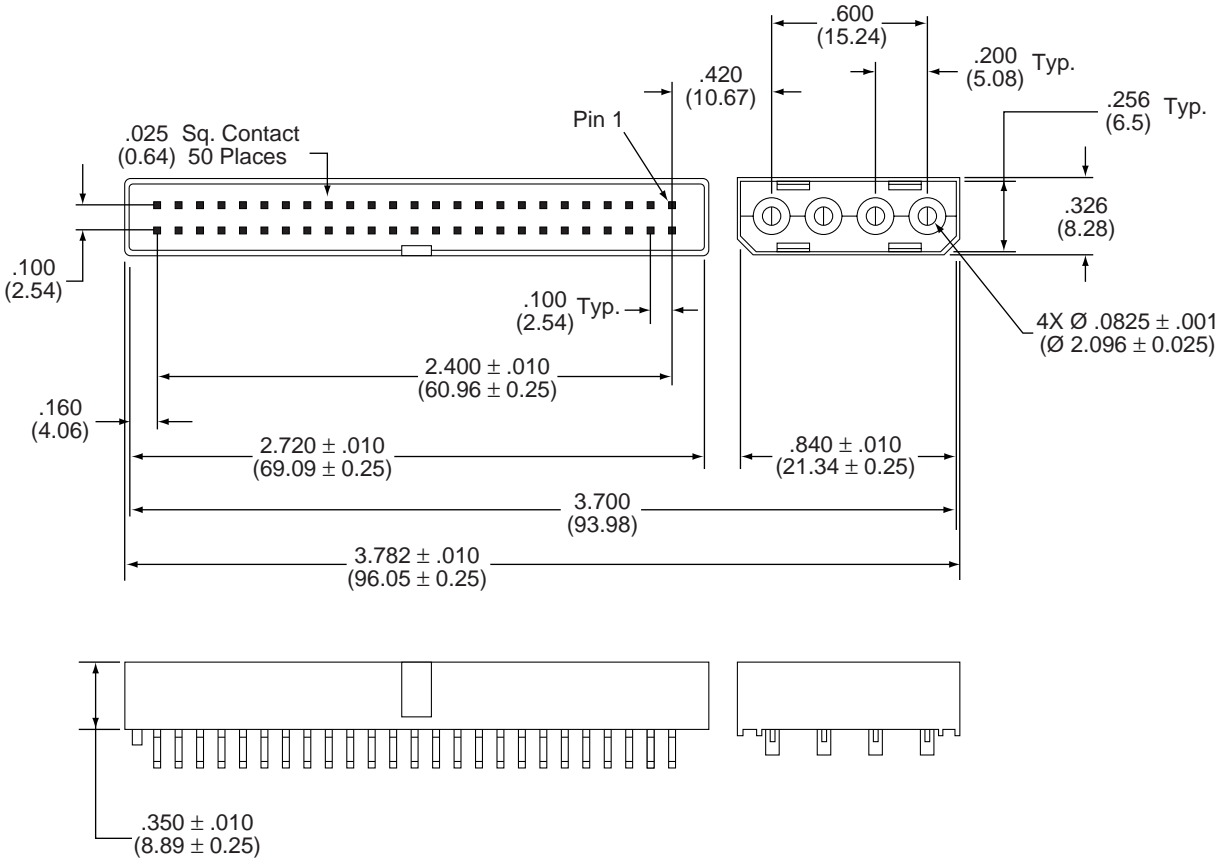
Figure 15.   Non-shielded 50-pin SCSI device connector
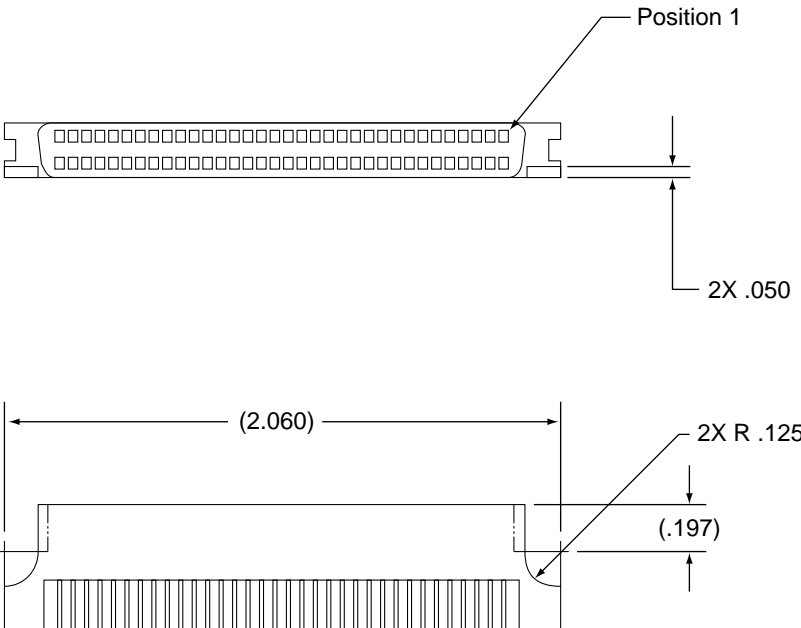
Figure 16.   Non-shielded 68-pin SCSI device connector

Table 12: Single-ended signal/contact assignments for ST423451N drives

Signal name [1]	Connector contact number [6]	Cable conductor number [5]		Connector contact number [6]	Signal name [1]
GND	1	1	2	2	–DB0
GND	3	3	4	4	–DB1
GND	5	5	6	6	–DB2
GND	7	7	8	8	–DB3
GND	9	9	10	10	–DB4
GND	11	11	12	12	–DB5
GND	13	13	14	14	–DB6
GND	15	15	16	16	–DB7
GND	17	17	18	18	–DBP
GND	19	19	20	20	GND
GND	21	21	22	22	GND
GND	23	23	24	24	GND
NC [4]	25*	25	26	26	TERMPWR
GND	27	27	28	28	GND
GND	29	29	30	30	GND
GND	31	31	32	32	–ATN
GND	33	33	34	34	GND
GND	35	35	36	36	–BSY
GND	37	37	38	38	–ACK
GND	39	39	40	40	–RST
GND	41	41	42	42	–MSG
GND	43	43	44	44	–SEL
GND	45	45	46	46	–C/D
GND	47	47	48	48	–REQ
GND	49	49	50	50	–I/O

*CAUTION: Connector contact 25 must not be connected to ground at the host end or the drive end of the cable. If the I/O cable should accidentally be plugged in upside down, terminator power on pin 26 will be shorted to ground.

Notes [ ]: See page following Table 14.

Table 13: Single-ended wide cable assignments for ST423451W drives

Signal name [1]	Connector contact number [3]	Cable conductor number [2]		Connector contact number [3]	Signal name [1]
GND	1	1	2	35	−DB12
GND	2	3	4	36	−DB13
GND	3	5	6	37	−DB14
GND	4	7	8	38	−DB15
GND	5	9	10	39	−DBP1
GND	6	11	12	40	−DB0
GND	7	13	14	41	−DB1
GND	8	15	16	42	−DB2
GND	9	17	18	43	−DB3
GND	10	19	20	44	−DB4
GND	11	21	22	45	−DB5
GND	12	23	24	46	−DB6
GND	13	25	26	47	−DB7
GND	14	27	28	48	−DBP
GND	15	29	30	49	GND
GND	16	31	32	50	GND
TERMPWR	17	33	34	51	TERMPWR
TERMPWR	18	35	36	52	TERMPWR
RESERVED	19	37	38	53	RESERVED
GND	20	39	40	54	GND
GND	21	41	42	55	−ATN
GND	22	43	44	56	GND
GND	23	45	46	57	−BSY
GND	24	47	48	58	−ACK
GND	25	49	50	59	−RST
GND	26	51	52	60	−MSG
GND	27	53	54	61	−SEL
GND	28	55	56	62	−C/D
GND	29	57	58	63	−REQ
GND	30	59	60	64	−I/O
GND	31	61	62	65	−DB8
GND	32	63	64	66	−DB9
GND	33	65	66	67	−DB10
GND	34	67	68	68	−DB11

Notes [ ]: See page following Table 14.

Table 14:   **Wide differential P cable assignments (non-shielded connector) for ST423451WD drives**

Note.   The minus sign next to the signal indicates asserted state is the low voltage of the two levels used for logic signals.

Signal Name [1]	Connector Contact Number [3]	Cable Conductor Number [2]		Connector Contact Number [3]	Signal Name [1]
+DB12	1	1	2	35	−DB12
+DB13	2	3	4	36	−DB13
+DB14	3	5	6	37	−DB14
+DB15	4	7	8	38	−DB15
+DBP1	5	9	10	39	−DBP1
GND	6	11	12	40	GND
+DB0	7	13	14	41	−DB0
+DB1	8	15	16	42	−DB1
+DB2	9	17	18	43	−DB2
+DB3	10	19	20	44	−DB3
+DB4	11	21	22	45	−DB4
+DB5	12	23	24	46	−DB5
+DB6	13	25	26	47	−DB6
+DB7	14	27	28	48	−DB7
+DBP	15	29	30	49	−DBP
DIFFSENS	16	31	32	50	GND
TermPwr	17	33	34	51	TermPwr
TermPwr	18	35	36	52	TermPwr
Reserved	19	37	38	53	Reserved
+ATN	20	39	40	54	−ATN
GND	21	41	42	55	GND
+BSY	22	43	44	56	−BSY
+ACK	23	45	46	57	−ACK
+RST	24	47	48	58	−RST
+MSG	25	49	50	59	−MSG
+SEL	26	51	52	60	−SEL
+C/D	27	53	54	61	−C/D
+REQ	28	55	56	62	−REQ
+I/O	29	57	58	63	−I/O
GND	30	59	60	64	GND
+DB8	31	61	62	65	−DB8
+DB9	32	63	64	66	−DB9
+DB10	33	65	66	67	−DB10
+DB11	34	67	68	68	−DB11

Notes [ ]: See page following this table.

Notes [ ] for Tables 12, 13, and 14:

[1]   See Section 9.7.1 for detailed electrical characteristics of these signals.

[2]   The conductor number refers to the conductor position when using 0.025-inch (0.635 mm) centerline flat ribbon cable. Other cable types may be used to implement equivalent contact assignments.

[3]   Connector contacts are on 0.050 inch (1.27 mm) centers.

[4]   "NC" means no connection.

[5]   The conductor number refers to the conductor position (right to left in Figure 14) when using 0.050 inch (1.27 mm) centerline flat ribbon cable. Other cable types may be used to implement equivalent contact assignments.

[6]   Connector contacts are on 0.100 inch (2.54 mm) centers.

[7]   8 bit devices which are connected to the 16 data bit differential I/O shall leave the following signals open:
  –DB12 –DB13 –DB14 –DB15 –DBP1 –DB8 –DB9 –DB10 –DB11.
  +DB12 +DB13 +DB14 +DB15 +DBP1 +DB8 +DB9 +DB10 +DB11.
  8 bit devices which are connected to the 16 data bit single-ended I/O shall have the following signals connected as shown:
    to ground: +DB12 +DB13 +DB14 +DB15 +DBP1 +DB8 +DB9 +DB10 +DB11.
    open circuit: –DB12 –DB13 –DB14 –DB15 –DBP1 –DB8 –DB9 –DB10 –DB11.
  All other signals shall be connected as defined.

[8]   GND provides a means for differential devices to detect the presence of a single-ended device on the bus.

9.7 Electrical description

ST423451N and ST423451W models use single-ended interface signals. These signals must be terminated with 110-ohm active termination circuits at each end of the total cable. Single-ended circuits use open collector or three state drivers. All of these models can be configured to provide the SCSI termination.

ST423451WD models use differential interface signals and each of these must be terminated at each end of the total cable with 330 ohms to +5 V and 330 ohms to ground with 150 ohms between each differential pair. All I/O circuits are open collector, three state drivers. Differential I/O drives are shipped without terminators. These drives have no provisions for adding terminator sockets on the PCB. This means some method of external termination must be provided by the user when termination is required.

9.7.1 Single-ended drivers/receivers

Typical single-ended driver and receiver circuits are shown in Figure 17. Use terminator circuits only where the disc drive is first or last in the daisy chain. See Note 1 following Figure 17.

Transmitter characteristics

Single-ended drives use an ANSI SCSI compatible open collector single-ended driver. This driver is capable of sinking a current of 48 mA with a low level output voltage of 0.4 volt.

Receiver characteristics

Single-ended drives use an ANSI SCSI single-ended receiver with hysteresis gate or equivalent as a line receiver.
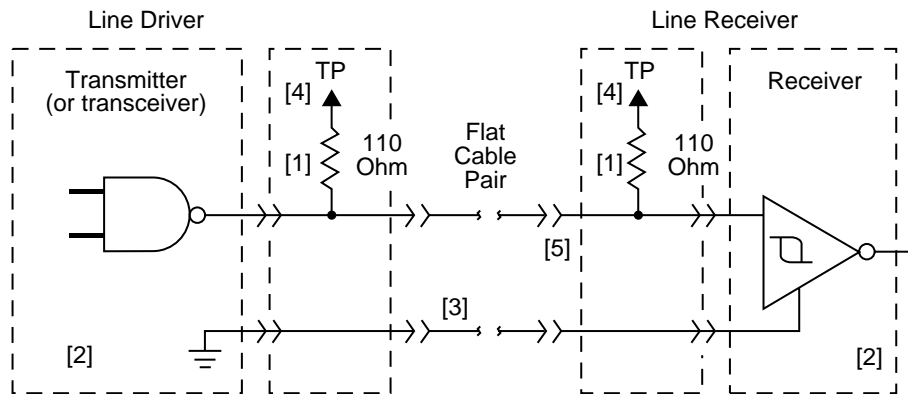
Figure 17. Single-ended transmitters and receivers

Notes.

[1] Part of active terminator circuits. Non-removable LSI terminators, enabled in the drive ("N" and "W" models only) with jumper plug **TE** when it is the first or last in the daisy chain.
[2] ANSI SCSI compatible circuits.
[3] Total interface cable length should not exceed that specified in Section 9.6.3.1.
[4] Source of drive terminator power is an active circuit which has an input source voltage selected by jumper plug **TP**. See Figures 8 and 9a. Applies to "N" and "W" models only.
[5] Interface signal levels and logical sense at the drive I/O connector for "N," "W," and "WC" models are defined as follows:

Vil (low-level input voltage) = 1.0 V maximum (signal true); minimum = Vss − 0.5 V.

Vih (high-level input voltage) = 1.9 V minimum (signal false); maximum = Vdd +0.5V.

Vihys (Input Hysteresis) = 425 mV minimum

9.7.2   Differential drivers/receivers

Typical differential driver and receiver circuits used by ST423451WD drives are shown in Figure 18. The drive has no provisions for terminator circuits on differential I/O drives.

Differential signals

All differential interface signals consist of two lines denoted +SIGNAL and –SIGNAL. A signal is true when +SIGNAL is more positive than –SIGNAL, and a signal is false when –SIGNAL is more positive than +SIGNAL. All assigned signals must be terminated at each end of the cable. You must provide external termination for the differential drives.

Output characteristics

Each signal driven by differential interface drives should have the following output characteristics when measured at the disc drive's SCSI connector:

Low-level output voltage*
= 2.0 V maximum at low-level output current
= 55 milliamps

High-level output voltage*
= 3.0 V minimum at high-level output current
= –55 milliamps

Differential voltage
= 1.0 V minimum with common-mode voltage ranges from –7 V DC to +12 V DC

*Measure these voltages between the output terminal and the SCSI device's logic ground reference.

The output characteristics must additionally conform to EIA RS-485-1983.

Input characteristics

Each signal received by differential interface drives should have the following input characteristics when measured at the disc drive's SCSI connector:

Input current on either input

= +2.0 milliamps maximum (includes both receivers and passive drivers)

This requirement is met with the input voltage varying between –7 V DC and +12 V DC, with power on or off, and with the hysteresis equaling 35 mV minimum.

The input characteristics must additionally conform to EIA RS-485-1983.

SCSI Device at Beginning of I/O Cable
(usually Host Adaptor/Initiator)

SCSI Device at End of I/O Cable
(Drive/Target)
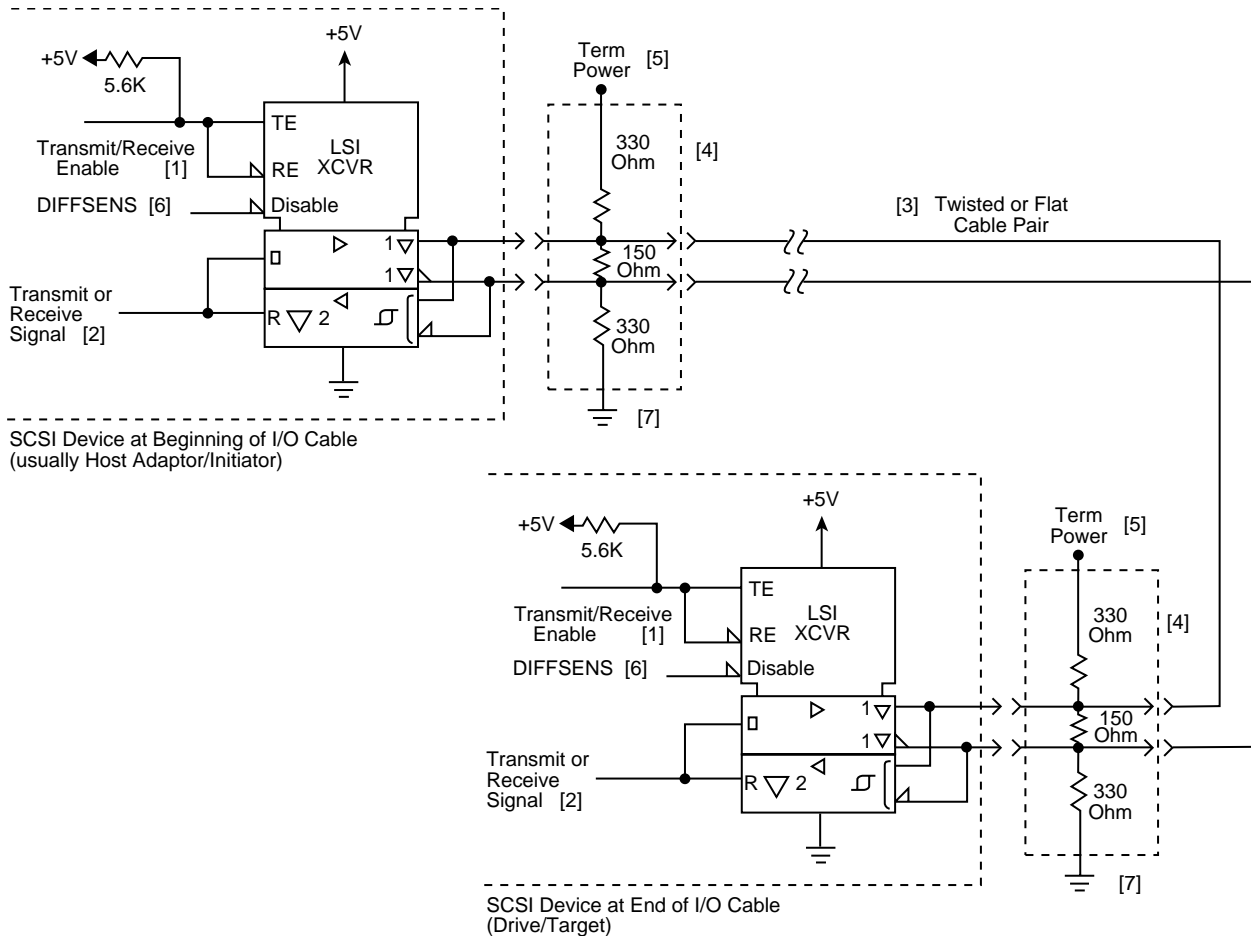
Notes.

[1] Positive logic enables transmitter (+5 V = asserted).
Negative logic enables receivers (0 V = asserted).

[2] Negative logic signal (0 V = asserted).

[3] Total interface cable length should not exceed value given in Section 9.6.3.2 from first SCSI device at beginning to end of daisy chain. See Section 9.7.2 for signal characteristics.

[4] I/O line terminators. If SCSI device is a Seagate disc drive, terminators and a place to plug them in must be provided external to the drive by user, systems integrator, or host equipment manufacturer where needed. The drive has no terminators and there are no provisions on the drive for terminator installation.

[5] Arrangements for connecting terminator power to the terminators must be made by the systems designer. As a help, drive +5 V power is made available on SCSI bus ("N," "W," and "WD" models) for powering external terminators if the drive option select header jumper **TP** (Figures 8 and 9a) is installed in rightmost position **"TP."** See pin assignment Table 14 for pins assigned to terminator power.

[6] SCSI I/O line (pin 21) disables I/O circuits if single-ended cable plugged in or cable plugged in upside down.

[7] SCSI I/O cable ground. See Table 14.

Figure 18.   Typical differential I/O line transmitter/receiver and terminators

9.8 Terminator requirements

ST423451N and ST423451W drives

Internal disc drive I/O termination consists of active circuits contained in an LSI module that is permanently mounted on the PCB. All single initiator/single target (non-daisy-chain) applications require you to terminate the initiator and drive.

Terminate both ends of the SCSI bus with ANSI SCSI-2 standard alternative 2 (active) termination. Do not mix active and passive terminators on the same SCSI bus.

Daisy-chain configurations require you to terminate only the units at each end of the daisy chain. Do not terminate any other peripherals on the chain.

Note. Remove the Enable SCSI Terminator **(TE)** jumper from J4A pins 19 and 20 when terminators are not required.

ST423451WD drives

Differential I/O Elite drives do not have provisions to add terminator sockets on the PCB. You must provide external termination when termination is required. Terminator plugs that fit between the cable connector and the drive connector can be purchased. See Figure 14.

9.9 Terminator power

ST423451N and ST423451W drives

You can configure terminator power in four different ways. See Section 8.1 for illustrations that show how to place jumpers enabling each of the following terminator power configurations:

1. Drive accepts terminator power through SCSI bus pins:
    ST423451N   Pin 26
    ST423451W/WD Pins 17, 18, 51, and 52
2. Drive supplies power to the SCSI bus.
3. Drive provides power to its own terminators and to the SCSI bus terminator power line.

SCSI devices providing terminator power (TERMPWR) must have the following characteristics:

V TERM = 4.50 V to 5.25 V
800 mA minimum source drive capability
1.0 A maximum

ST423451WD drives

You can configure terminator power from the drive to the SCSI bus or have the host adaptor or other device supply terminator power to the external terminator. See Section 8.1 for illustrations that show how to place jumpers for this configuration.

9.10   Disc drive SCSI timing

Table 15:   Disc drive SCSI timing

Description	Waveform symbol [1]	Waveform table [1]	Typical timing	Maximum timing
Target select time (no arbitration)	T00	N/A	<1 µs	<250 µs
Target select time (with arbitration)	T01	4.5-1,2	2.31 µs	2.36 µs
Target select to command	T02	4.5-1	3.33 µs	3.34 µs
Target select to MSG out	T03	4.5-2	1.51 µs	1.54 µs
Identify MSG to command	T04	4.5-3	3.34 µs	3.36 µs
Command to status	T05	4.5-5	Command dependent	Command dependent
Command to data (para. in)	T06	4.5-9	Command dependent	Command dependent
Command to data (para. out)	T07	4.5-10	Command dependent	Command dependent
Command to data (write to data buffer)	T08	4.5-10	Command dependent	Command dependent
Command to disconnect MSG	T09	4.5-6	Command dependent	Command dependent
Disconnect MSG to bus free	T10	4.5-6,14	0.64 µs	0.68 µs
Disconnect to arbitration (for reselect) This measures disconnected CMD overhead.	T11	4.5-6–b	Command dependent	Command dependent
Target win arbitration (for reselect)	T12	4.5-7		2.8 µs
Arbitration to reselect	T13	4.5-7		1.8 µs
Reselect to identify MSG in	T14	4.5-7		1.34 µs
Reselect identify MSG to status	T15	4.5-8	Command dependent	Command dependent
Reselect identify MSG to data (media)	T16	4.5-11	Command dependent	Command dependent
Data to status	T17	4.5-15	Command dependent	Command dependent
Status to command complete MSG	T18	4.5-5,8,15		1.0 µs
Command complete MSG to bus free	T19	4.5-5,8,15		0.75 µs
Data to save data pointer MSG	T20	4.5-14		4.5 µs
Save data pointer MSG to disconnect MSG	T21	4.5-14		0.75 µs
Command byte transfer	T22	4.5-4		0.04 µs
Next command byte access		4.5-4		
Next CDB byte access (byte 2 of 6)	T23.6.2	4.5-4	0.55 µs	0.56 µs
Next CDB byte access (byte 3 of 6)	T23.6.3	4.5-4	0.10 µs	0.10 µs
Next CDB byte access (byte 4 of 6)	T23.6.4	4.5-4	0.09 µs	0.10 µs
Next CDB byte access (byte 5 of 6)	T23.6.5	4.5-4	0.13 µs	0.14 µs
Next CDB byte access (byte 6 of 6)	T23.6.6	4.5-4	0.13 µs	0.14 µs
Next CDB byte access (byte 2 of 10)	T23.10.2	4.5-4	0.59 µs	0.60 µs
Next CDB byte access (byte 3 of 10)	T23.10.3	4.5-4	0.14 µs	0.14 µs
Next CDB byte access (byte 4 of 10)	T23.10.4	4.5-4	0.13 µs	0.14 µs
Next CDB byte access (byte 5 of 10)	T23.10.5	4.5-4	0.12 µs	0.12 µs
Next CDB byte access (byte 6 of 10)	T23.10.6	4.5-4	0.11 µs	0.12 µs
Next CDB byte access (byte 7 of 10)	T23.10.7	4.5-4	0.10 µs	0.10 µs
Next CDB byte access (byte 8 of 10)	T23.10.8	4.5-4	0.09 µs	0.10 µs

Description	Waveform symbol [1]	Waveform table [1]	Typical timing	Maximum timing
Next CDB byte access (byte 9 of 10)	T23.10.9	4.5-4	0.13 µs	0.14 µs
Next CDB byte access (byte 10 of 10)	T23.10.10	4.5-4	0.12 µs	0.12 µs
Data in byte transfer (parameter)	T24	4.5-12		0.04 µs
Data out byte transfer (parameter)	T25	4.5-13		0.04 µs
Next data in byte access (parameter)	T26	4.5-12	0.10 µs	0.12 µs
Next data byte out access (parameter)	T27	4.5-13	0.10 µs	0.12 µs
Data in byte transfer (media) [2]	T28	4.5-12	0.03 µs	0.04 µs
Data out byte transfer (media) [2]	T29	4.5-13	0.03 µs	0.04 µs
Next data in byte access (media) [2]	T30	4.5-12	0.10 µs	0.12 µs
Next data out byte access (media) [2]	T31	4.5-13	0.10 µs	0.12 µs
MSG IN byte transfer	T32	4.5-5,7, 4.5-8,14,15	0.09 µs	0.04 µs
MSG OUT byte transfer	T33	4.5-2		0.04 µs
STATUS byte transfer	T34	4.5-5,8, 4.5-15		0.04 µs
Synchronous data transfer characteristics:				
Request signal transfer period [3]	–	–	various	800 ns

Notes.

[1] See the *SCSI Interface Product Manual,* part number 77738479, Section 4.5.

[2] Maximum SCSI asynchronous interface transfer rate is given in Section 4.2.3.

[3] Synchronous Transfer Period is determined by negotiations between an Initiator and a Drive. The Drive is capable of setting periods as given in Section 9.5. See also Sections 3.1.5.2 and 3.5.3.2 of the *SCSI Interface Product Manual,* part number 77738479, for a description of synchronous data transfer operation.

10.0   Seagate technical support services

If you need assistance installing your drive, consult your dealer. Dealers are familiar with their unique system configurations and can help you with system conflicts and other technical issues. If you need additional assistance with your Seagate® drive or other Seagate products, use one of the Seagate technical support services listed below.

SeaFONE® 1-800-SEAGATE

Seagate's 800 number (1-800-732-4283) allows toll-free access to automated self-help services, providing answers to commonly asked questions, troubleshooting tips, and specifications for disc drives and tape drives. This service is available 24 hours daily and requires a touch-tone phone. International callers can reach this automated self-help service by dialing 408-456-4496.

Online services

Using a modem, you can obtain troubleshooting tips, free utility programs, drive specifications and jumper settings for Seagate's entire product line. You can also download software for installing and analyzing your drive.

SeaNET™

You can obtain technical information about Seagate products over the Internet from Seagate's World Wide Web home page **(http://www.seagate.com)** or Seagate's ftp server **(ftp://ftp.seagate.com)**. You can also send E-mail with your questions to **DiscSupport @ Seagate.com** or **TapeSupport @ Seagate.com**.

Seagate CompuServe forum

Online technical support for Seagate products is available on CompuServe. To access our technical support forum, type **go seagate**. This forum provides information similar to that found on SeaBOARD. In addition, you can type questions or browse through previous questions and answers on the forum messages.

SeaBOARD®

SeaBOARD is a computer bulletin board system that contains information about Seagate disc and tape drive products and is available 24 hours daily. Set your communications software to eight data bits, no parity, and one stop bit (8-N-1).

Location	Phone number
Australia	61-2-9756-2359
England	44-1628-478011
France	33 1-48 25 35 95
Germany	49-89-140-9331
Singapore	TBA
Taiwan	886-2-719-6075
Thailand	662-531-8111
USA	Disc: 408-434-1080; Tape: 408-456-4415

FAX services

SeaFAX®

You can use a touch-tone telephone to access Seagate's automated FAX system to receive technical support information by return FAX. This service is available 24 hours daily.

Location	Phone number
Australia	61-2-9756-5170
England	44-1628-894084
USA	1-800-SEAGATE or 408-456-4496

Seagate technical support FAX

You can FAX questions or comments to technical support specialists 24 hours daily. Responses are sent during business hours.

Location	Phone number
Australia	61-2-9725-4052
England	44-1628-890660
France	33 1-46 04 42 50

Location	Phone number
Germany	49-89-1430-5100
Hong Kong	852-2368 7173
Japan	81-3-5462-2979
Korea	82-2-556-7294/4251
Singapore	65-488-7528
Taiwan	886-2-715-2923
USA	408-944-9120

Direct-support services

Seagate technical support

For one-on-one help, you can talk to a technical support specialist during local business hours. Before calling, note your system configuration and drive model number (ST*xxxx*).

Location	Phone number
Australia	61-2-9725-3366 (9:00 A.M. to 5:00 P.M., M–F)
England	44-1628-894083 (10:00 A.M. to 1:00 P.M., 2:00 P.M. to 5:00 P.M., M–F)
France	33 1-41 86 10 86 (9:30 A.M. to 12:30 P.M., 2:00 P.M. to 5:00 P.M., M–F)
Germany	Disc: 49-89-140-9332; Tape: 49-89-140-9333
	(9:30 A.M. to 12:30 P.M., 2:00 P.M. to 4:00 P.M., M–F)
Hong Kong	852-2368 9918
Korea	82-2-556-8241
Singapore	65-488-7584 (9:00 A.M. to 12:00 P.M., 2:00 P.M. to 5:00 P.M., M–F)
Taiwan	886-2-514-2237
USA	Please dial 1-800-SEAGATE or 408-456-4496 for the specific product telephone number.
	(6:00 A.M. to 11:15 A.M., 12:30 P.M. to 5:00 P.M., Pacific time, M–F)

SeaTDD™ *408-944-9121*

Using a telecommunications device for the deaf (TDD), you can send questions or comments 24 hours daily and exchange messages with a technical support specialist between 6:00 A.M. to 11:15 A.M. and 12:30 P.M. to 5:00 P.M. (Pacific time) Monday through Friday.

Customer service centers

Seagate direct OEM, Distribution, and System Integrator customers should contact their Seagate service representative for warranty information. Other customers should contact their place of purchase. Seagate offers comprehensive customer support for all Seagate drives. These services are available worldwide.

Location	Phone number	FAX number
Asia Pacific and Australia	65-485-3595	65-485-4980
Europe, Middle East, and Africa	31-2031-67300	31-2065-34320
Japan	81-3-5462-2904	81-3-5462-2979
USA	1-800-468-3472	405-949-6740
Other Americas (Brazil, Canada, Mexico)	405-949-6706	405-949-6738
Manufacturer's representatives		
Brazil		
MA Informatica	55-11-810-7794	55-21-253-6467
Canada		
Memofix	905-660-4936	905-660-8738
Adtech	905-812-8099	905-812-7807
	1-800-624-9857	
Mexico		
Abicom Seamax SA DE CV	525-546-6965	525-546-4888

Index