Seagate

# *Barracuda 4XL Family:*

# *ST34572N/W/WD/WC/DC*

# *ST32272N/W/WD/WC/DC*

*Product Manual, Volume 1*

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# *ST34572N/W/WD/WC/DC*

# *ST32272N/W/WD/WC/DC*

*Product Manual, Volume 1*

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| A Issue | 03/26/97 | L. Newman/A. Ukani | 1/1, v thru viii, 1 thru 82. |
| B | 11/04/97 | L. Newman/A. Ukani | 8, 9, 10, 28, 29, 30, 47, 49, 50, and 72. |

**Notice.**

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

# Contents

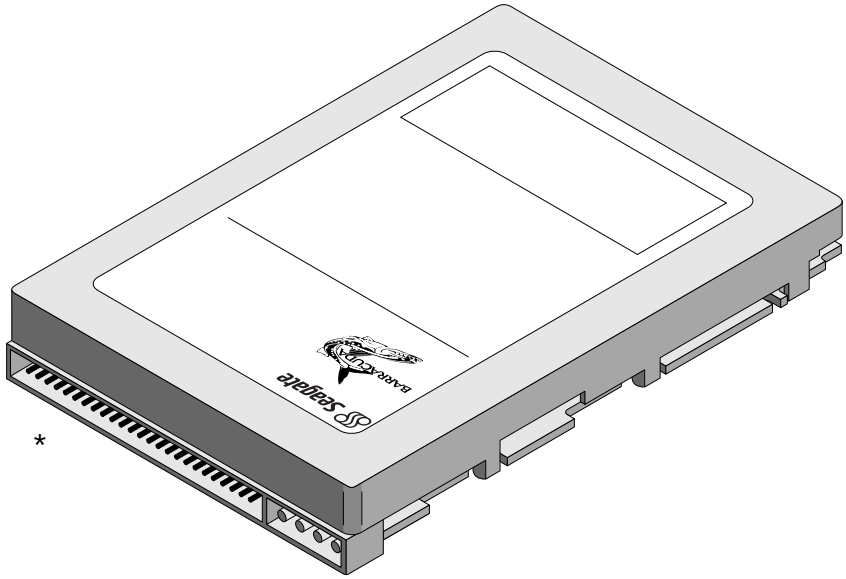
# Figures

## 1.0 Scope

This manual describes the Seagate Technology®, Inc. Barracuda 4XL™ disc drives.

Barracuda 4XL 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 Barracuda 4XL models is referred to as “the drive” (unless references to individual models are necessary).




*Model “N” version with 50 pin SCSI I/O connector

**Figure 1. Barracuda 4XL family drive**

# 2.0 Applicable standards and reference documentation

The drive has been developed as a system peripheral to the highest standards of design and construction. The drive depends upon its host equipment to provide adequate power and environment in order to achieve optimum performance and compliance with applicable industry and governmental regulations. Special attention must be given in the areas of safety, power distribution, shielding, audible noise control, and temperature regulation. In particular, the drive must be securely mounted in order to guarantee the specified performance characteristics. Mounting by bottom holes must meet the requirements of Section 8.4.

## 2.1 Standards

Barracuda 4XL family drives comply with Seagate standards as noted in the appropriate sections of this manual and the Seagate *SCSI Interface Product Manual*, part number 77738479 (Vol. 2).

Barracuda 4XL disc drives are UL recognized components 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 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 to the enclosure and to the host controller.

### 2.1.2 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

| | |
|---|---|
| Barracuda 4XL Installation Guide: | Seagate P/N 77767501 |
| SCSI Interface Product Manual: | Seagate P/N 77738479 |

ANSI Small Computer System Interface (SCSI): ANSI3.131-1986 (X3T9/84.40 Rev. 1B) (X3T9.2/82-2 Rev. 17B), X3T9.2/86-109 Revision 10H (SCSI-2), X3T9.2/91/010 Rev. 10 (SCSI-3) parallel interface, X3T9.2-184 Rev. 4 (SCSI-3) and ANSI SCSI-3 Fast-20, X3T10/1071D.

| | |
|---|---|
| Package Test Specification | Seagate P/N 30190-001 (under 100 lb.) |
| Package Test Specification | Seagate P/N 30191-001 (over 100 lb.) |
| Specification, Acoustic Test Requirements: | Seagate P/N 30553-001 |

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

## 3.0 General description

Barracuda 4XL 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 Barracuda 4XL SCSI-3 Fast-20 (Ultra SCSI) models.

**Table 1: Drive model number vs. differentiating features**

| Model number | Number of heads | I/O circuit type | Number of I/O connector pins | Number of I/O data bus bits |
|---|---|---|---|---|
| ST34572N | 8 | single-ended | 50 | 8 |
| ST34572W | 8 | single-ended | 68 | 16 |
| ST34572WD | 8 | differential | 68 | 16 |
| ST34572WC | 8 | single-ended | 80 | 16 |
| ST34572DC | 8 | differential | 80 | 16 |
| ST32272N | 4 | single-ended | 50 | 8 |
| ST32272W | 4 | single-ended | 68 | 16 |
| ST32272WD | 4 | differential | 68 | 16 |
| ST32272WC | 4 | single-ended | 80 | 16 |
| ST32272DC | 4 | differential | 80 | 16 |

The drive records and recovers data on 3.5-inch (86 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 Barracuda 4XL 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.

Barracuda 4XL 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.

Barracuda 4XL 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.

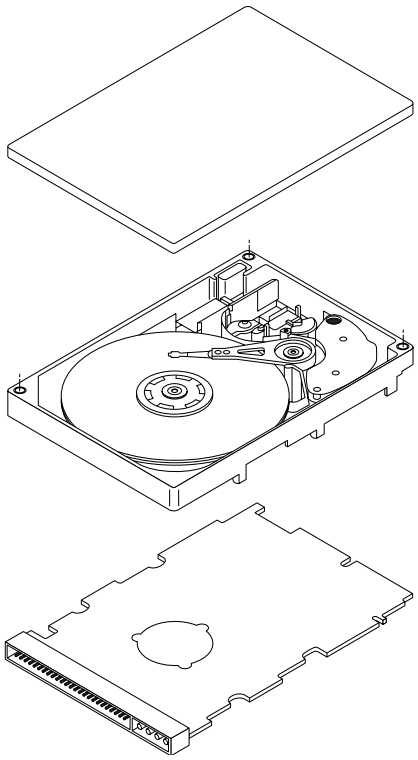


**Figure 2. Barracuda 4XL family drive**

### 3.1 Standard features

The Barracuda 4XL family has the following standard features:

- Integrated SCSI controller
- Single-ended and differential SCSI drivers and receivers
- 8 bit and 16 bit I/O data bus models available
- Asynchronous and synchronous data transfer protocol
- Firmware downloadable via SCSI interface
- Selectable even byte sector sizes from 180 to 4,096 bytes/sector
- Programmable drive capacity
- Programmable sector reallocation scheme
- Flawed sector reallocation at format time
- Programmable auto write and read reallocation
- Reallocation of defects on command (Post format)
- 128-bit Reed-Solomon error correcting code
- Sealed head and disc assembly
- No preventative maintenance or adjustment required
- Dedicated laser textured 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
- Zoned bit recording (ZBR)
- Vertical, horizontal, or top down mounting
- Dynamic spindle brake
- Active IC terminators enabled by jumpers (“N” and “W” models only)
- 512 K byte data buffer
- Hot plug compatibility (section 9.6.4.3 lists the proper host connector needed) for “WC” and “DC” drives
- SCAM (SCSI Configured AutoMagically) plug-n-play level 2 compliant
- Low audible noise for office environment
- Low power consumption
- Audio Visual (A/V) ready

### 3.2 Media characteristics

The media used on the drive has a diameter of approximately 3.5 inches (86 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 Ultra SCSI interface (also called “Fast-20 SCSI”)
- Programmable multi-segmentable cache buffer
- 7200 RPM spindle. Average latency = 4.17 ms
- Command queuing of up to 64 commands
- Background processing of queue
- Supports start and stop commands (spindle stops spinning)

### 3.4 Reliability

- 1,000,000 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)
- 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 the standard OEM model read capacity data. Total LBAs = read capacity data shown below + 1.

| Model | Formatted [1] data block size 512 byte/sector | Unformatted | Sparing |
|---|---|---|---|
| ST34572 | 87A25Bh (4.55 GB) | 6.5 GB | 118 spares per six cylinder region |
| ST32272 | 436F87h (2.26 GB) | 3.25 GB | 59 spares per six cylinder region |

**Notes.**

[1] 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).

### 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, bytes 1, 2 and 3. A value of zero in bytes 1, 2 and 3 indicates that the drive shall not change the capacity it is currently formatted to have. A number in bytes 1, 2 and 3 that is less than the maximum number of LBAs changes the total drive capacity to the value in the block descriptor bytes 1, 2 and 3. A value greater than the maximum number of LBAs is rounded down to the maximum capacity.

### 3.7 Factory installed accessories

OEM Standard drives are shipped with *Barracuda 4XL Installation Guide* (part number 77767501) unless otherwise specified. The factory also ships with the drive a small bag of the two jumper plug types used for the J6, J2, and J1-Aux option select jumper headers.

### 3.8 Options (factory installed)

All customer requested options 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 *Barracuda 4XL Installation Guide* (part number 77767501) is usually included with each standard OEM drive. You may order additional copies of this publication.

### 3.9 Accessories (user installed)

The following accessories are available. Qualified individuals can install these accessories in the field.

- Front panel kit (with green rectangular LED lens), part number 73501451.
- Single unit shipping pack.
- *Barracuda 4XL Installation Guide* (part number 77767501).

# 4.0 Performance characteristics

## 4.1 Internal drive characteristics (transparent to user)

| | ST34572 | ST32272 | |
|---|---|---|---|
| Drive Capacity | 6.5 | 3.25 | GByte (unformatted) |
| Read/Write Heads | 8 | 4 | |
| Bytes/Track | 124,000 | 124,000 | Bytes (average, unformatted) |
| Bytes/Surface | 812.5 | 812.5 | Mbytes (unformatted) |
| Tracks/Surface, Total | 6,311 | 6,311 | Tracks (user accessible) |
| Tracks/Inch | 6,800 | 6,800 | TPI |
| Peak Bits/Inch | 139,209 | 139,209 | BPI |
| Internal Data Rate | 92-140 | 92-140 | Mbits/sec (variable with zone) |
| Disc Rotational Speed | 7,200 | 7,200 | r/min |
| Average Rotational Latency | 4.17 | 4.17 | ms |

## 4.2 SCSI Seek performance characteristics (visible to user) [6]*

The values given in Section 4.2.1 apply to all models of the Barracuda 4XL family 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 [8]

| | | | | Including Controller Overhead (without disconnect) [1] [4] Drive Level Read | Write |
|---|---|---|---|---|---|
| | | | | ms | |
| Average | – | Typical | [3] | 9.4 | 10.4 |
| | | Maximum | [2] | 10.8 | 11.9 |
| Single Track | – | Typical | [3] | 1.7 | 1.8 |
| | | Maximum | [2] | 1.8 | 1.9 |
| Full Stroke | – | Typical | [3] | 16.7 | 17.7 |
| | | Maximum | [2] | 19.7 | 20.2 |

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

### 4.2.2 Format command execution time (minutes) [1]*

| | ST34572 | ST32272 |
|---|---|---|
| Maximum (with verify) | 95 | 50 |
| Maximum (no verify) | 65 | 35 |

### 4.2.3 Generalized performance characteristics

Minimum sector interleave 1 to 1

Data buffer transfer rate to/from disc media (one 512-byte sector):

| | | | |
|---|---|---|---|
| Min. | [4]* | 11.5 | MByte/sec |
| Avg. | [4] | 15.5 | MByte/sec |
| Max. | [4] | 17.5 | MByte/sec |

Data buffer transfer rate to/from disc media: (< 1 track):

| | | | | |
|---|---|---|---|---|
| Min. | [4] | 7.86 | MByte/sec | divided by (interleave factor) |
| Avg. | [4] | 11.0 | MByte/sec | divided by (interleave factor) |
| Max. | [4] | 12.5 | MByte/sec | divided by (interleave factor) |

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

| | |
|---|---|
| Maximum instantaneous | 6.0 Mbytes/sec [6] |
| Maximum average | 6.0 Mbytes/sec [7] |
| Synchronous transfer rate for SCSI Fast-20 (Ultra SCSI): (8 bit data bus models) | 1.25 to 20 Mbytes/sec |
| Synchronous transfer rate for SCSI Fast-20 (Ultra SCSI): (16 bit data bus models) | 2.5 to 40 Mbytes/sec |
| Synchronous transfer rate for fast SCSI-2: (8 bit data bus models) | 1.25 to 10 Mbytes/sec |
| Synchronous transfer rate for fast SCSI-2: (16 bit data bus models). | 2.5 to 20 Mbytes/sec |
| Sector Sizes: | |
| Default | 512 byte user data blocks |
| Variable | 180 to 4,096 bytes per sector in even number of bytes per sector.<br>If n (number of bytes per sector) is odd, then n-1 will be used. |

| | |
|---|---|
| Read/write consecutive sectors on a track | Yes |
| Flaw reallocation performance impact (for flaws reallocated at format time using the spare sectors per sparing region reallocation scheme.) | Negligible |
| Overhead time for head switch (512 byte sectors) in sequential mode | 1 msec |
| Overhead time for one track cylinder switch in sequential mode | <2.4 msec (typical) |
| Average rotational latency | 4.17 msec |

*[ ] Notes listed at end of Section 4.2.3.

**Notes for Section 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, care should be taken to distinguish between typical access times and maximum access times. The best comparison is obtained by system benchmark tests conducted 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 has been relocated.

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

[6] Assumes system ability to support the rates listed and no cable loss.

[7] Simulated.

[8] Access time = controller overhead + average seek time
Access to data = controller overhead + average seek time + latency time

### 4.3 Start/stop time

After DC power at nominal voltage has been applied, the drive becomes ready within 20 seconds if the Motor Start Option is disabled (i.e. the motor starts as soon as the power has been applied). If a recoverable error condition is detected during the start sequence, the drive executes a recovery procedure which may cause the time to become ready to exceed 20 seconds. During spin up to ready time the drive responds to some commands over the SCSI interface in less than 3 seconds after application of power. Stop time is less than 20 seconds from removal of DC power.

If the Motor Start Option is enabled, the internal controller accepts the commands listed in the SCSI Interface Product Manual less than 3 seconds after DC power has been applied. After the Motor Start Command has been received the drive becomes ready for normal operations within 13 seconds typically (excluding an error recovery procedure). The Motor Start Command can also be used to command the drive to stop the spindle (see *SCSI Interface Product Manual*, part number 77738479).

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*, part number 77738479). 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 Tables 8 and 9.

### 4.5 Cache operation

In general, 480 Kbytes of the 512 Kbytes of physical buffer space in the drive can be used as storage space for cache operations. The buffer 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 maintains a table of logical block disk medium addresses of the data stored in each segment of the buffer. If cache operation is enabled (RCD bit = 0 in Mode Page 08h, byte 2, bit 0. See *SCSI Interface Product Manual* (part number 77738479), data requested by the host with a Read command is retrieved from the buffer (if it is there), 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* (part number 77738479).

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

**Case A -** A Read command is received and the first logical block (LB) is already in cache:

1. Drive transfers to the initiator the first LB requested plus all subsequent contiguous LB’s that are already in the cache. This data may be in multiple segments.
2. When the requested LB is reached that is not in any cache segment, the drive fetches it and any remaining requested LBs from the disc and puts them in a segment of the cache. The drive transfers the remaining requested LBs from the cache to the host in accordance with the disconnect/reconnect specification mentioned above.
3. If the prefetch feature is enabled, refer to Section 4.5.2 for operation from this point.

**Case B -** A Read command requests data, the first LB of which is not in any segment of the cache:

1. The drive fetches the requested LB’s from the disc and transfers them into a segment, and from there to the host in accordance with the disconnect/reconnect specification referred to in case A.
2. If the prefetch feature is enabled, refer to Section 4.5.2 for operation from this point.

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 can not 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 reported by the Mode Sense command page 08h, bytes 14 and 15. 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*, part number 77738479). The drive supports operation of any integer number of segments from 1 to 16.

### 4.5.1 Caching write data

Write caching is a write operation by the drive that makes use of a drive buffer storage area where the data to be written to the medium is stored in one or more segments while the drive performs the write command.

Write caching is enabled along with read caching. For write caching, the same buffer space and segmentation is used as set up for read functions. 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. 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 medium.

Tables 8 and 9 show Mode default settings for the drives.

### 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 disc 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 1 in $10^7$ seeks |
| Read Error Rates [1] | |
| Recovered Data | Less than 10 errors in $10^{11}$ bits transferred (default settings) |
| Unrecovered Data | Less than 1 sector in $10^{14}$ bits transferred (default settings) |
| Miscorrected Data | Less than 1 sector in $10^{21}$ bits transferred |
| MTBF | 1,000,000 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.

### 5.1.1 Environmental interference

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

An unrecoverable error, or unrecoverable 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 a write error unrecoverable 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 shall be no more than ten recoverable seek errors in $10^8$ physical seek operations. After detecting an initial seek error, the drive automatically reseeks to the addressed track up to 3 times. If a reseek is successful, the Extended Sense reports a seek positioning error (15h), no seek complete error (02h), or track follow error (09h), and the sense key reports a recovered error (1h). If all three reseeks fail, a seek positioning error (15h) is reported with a Medium error (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 5.1.1.2 of the *SCSI Interface Product Manual* (part number 77738479) for Request Sense information.

## 5.2 Reliability and service

You can enhance the reliability of Barracuda 4XL 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 service life of the drive. Section 8.3.1 provides recommended air-flow information.

### 5.2.1 Mean time between failure

The production disc drive shall achieve an MTBF of 1,000,000 hours when operated in an environment that ensures the case temperatures specified in Section 6.4.1 are not exceeded. Short-term excursions up to the specification limits of the operating environment will not affect MTBF performance.

The following expression defines MTBF

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

Estimated power-on operation hours means power-up hours per disc drive times the total number of disc drives in service. Each disc drive shall have accumulated at least nine months of operation. Data shall be 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 shall have a useful service life of five 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. In order to achieve the above service life, repairs must be performed 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. 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 since there are no user purchasable parts in the drive.

### 5.2.6 Hot plugging Barracuda 4XL disc drives

**Caution:** Hot-plug drives are not designed for simultaneous power disconnection and physical removal.

During power-up and power-down periods, the hot SCSI connect/disconnect capability does not produce glitches or any corruptions on an active SCSI bus. Barracuda 4XL drives conform to the SCSI-3 standard requirements for glitch-free power-on and power-off. The drive maintains the high-impedance state at the device connector contacts during a power cycle until the transceiver is enabled.

**Note.** The systems integrator must ensure that no temperature, energy, or voltage hazard is presented during the hot connect/disconnect operation.

Procedure:

1. Configure the drive with no connection between the drive and the TRMPWR signal on the SCSI bus. To accomplish this, remove all jumpers from connector J2 pins 1, 2, 3, and 4.
2. Ensure that all SCSI devices on the bus have receivers that conform to the SCSI-3 standard.
3. Eliminate all I/O processes for the drive.
4. Wait until the drive motor and discs have come to a complete stop prior to changing the plane of operation, ensuring data integrity.
5. Insert or remove the drive after meeting the following conditions:

**Caution:** Do not hot-plug the first or last device on the SCSI bus (the SCSI bus termination must be external to the drive you are inserting or removing).

   a. If you are inserting the drive, connect its power ground and logic ground at least 1 millisecond before coming into contact with the bus connector. Maintain these ground connections during and after connecting the device to the bus.

   b. If you are removing the device, maintain its power ground and logic ground connection for at least 1 millisecond after disconnecting the device from the bus.

   c. You may simultaneously switch the power to the electronics and mechanics of the drive with the bus contacts, if the power distribution system is able to maintain adequate power stability to other devices during the transition and if you have met the grounding requirements given in steps 5a and 5b.

   d. Ensure that the drive carrier discharges all static electricity prior to inserting the drive into the system.

**Note.** Do not remove or add terminator power or resistance to the SCSI bus while hot plugging a disc drive.

### 5.2.7 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 imminent drive failure, and provide sufficient warning of a failure to allow data back-up.

**Note.** The firmware will monitor specific attributes for degradation over time but can’t 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 SMART is controlled by the DEXCPT bit and the PERF bit of the “Informational Exceptions Control 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 is saved to the disc for the purpose of recreating the events that caused a predictive failure. The drive measures and saves 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. 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 with the following FRU values returned by the Request Sense command when a predictive failure threshold is reached. The error code is preserved through bus resets and power cycles.

**Predictive failure FRU codes**

| Attribute | FRU code | Predictive failure description |
|---|---|---|
| LBA reassignment | 04 (01-5D04) | LBA reassignment exceeding limits |
| Seek errors | 43 (01-5D43) | Seek error rate exceeding limits |
| Spinup errors | 5B (01-5D5B) | Spinup retry count exceeding limits |
| General failure | EF (01-5DEF) | Missing S.M.A.R.T. control information |

**Reassignment**. When a reassignment (reallocation) is performed, the code determines the percentage of entries still available in the Reallocation Table (RTB). If the percentage of entries left falls below a predetermined threshold value, a predictive failure is signaled.

**Seek errors**. Seek error rates are estimated on a per-head basis. For every seek, a seek interval counter is incremented and for every seek error a seek failure counter is incremented. If the seek error rate exceeds a predetermined threshold, the Seek Failure History counter is decremented (minimum value of zero). If the seek error rate is below a predetermined threshold, the Seek Failure History counter is incremented. Whenever a seek failure history counter changes, the corresponding Seek Interval counter and the seek failure counters are reset to zero, and a smoothing algorithm is performed. The firmware checks the Seek Failure counter for each head to determine the Seek Failure History counter with the largest value. The firmware will issue predictive failure if any single seek failure history counter has reached a predetermined threshold value.

**Spinup errors**. This attribute measures the “actuator buzz rate,” the number of actuator buzzes versus the number of drive spinups. If a drive fails to spinup using a normal spinup routine, if issues a level 1 and then level 3 actuator buzz to overcome drive stiction. For every spinup a spinup interval counter is incremented. If the servo firmware issues a level 1 or a level 3 actuator buzz command, the Spinup Failure counter adds a 1 or a 3 respectively. If the actuator buzz rate is below a predetermined threshold, the Spinup Failure History counter is decremented (minimum value of zero). If the actuator buzz rate is above a predetermined threshold, the Spinup Failure History counter is incremented.

When the Spinup Failure History counter changes, the Spinup Interval and the Spinup Failure counters are reset to zero and a smoothing algorithm is performed. The drive issues a predictive failure if the Spinup Failure History counter has reached a predetermined threshold value.

### 5.2.8 Product warranty

Beginning on the date of shipment to customer and continuing for a period of five 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. See Section 10.0.

# 6.0 Physical/electrical specifications

This section provides information relating to the physical and electrical characteristics of Barracuda 4XL 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 power connector. The single ended power requirements includes the internal disc drive SCSI I/O termination. The table shows current values in Amperes.

**Table 2: DC power requirements**

| | | ST34572 | | | | ST32272 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Notes | N/W/WC Single-ended | | WD/DC Differential | | N/W/WC Single-ended | | WD/DC Differential | |
| Voltage | | +5 V | +12 V | +5 V | +12 V | +5 V | +12 V | +5 V | +12 V |
| Regulation | [5] | ±5% | ±5% [2] | ±5% | ±5% [2] | ±5% | ±5% [2] | ±5% | ±5% [2] |
| Maximum operating current DC3σ | [1] | 0.81 | 0.95 | 1.21 | 0.95 | 0.81 | 0.85 | 1.21 | 0.85 |
| Average idle current DC$\overline{X}$ | [1] | 0.46 | 0.54 | 0.70 | 0.54 | 0.46 | 0.52 | 0.70 | 0.52 |
| Maximum starting current<br>(peak DC) DC3σ<br>(peak AC) AC3σ | <br>[3]<br>[3] | <br>0.78 | <br>2.44<br>3.1 | <br>1.1 | <br>2.44<br>3.1 | <br>0.78 | <br>2.00<br>3.1 | <br>1.1 | <br>2.00<br>3.1 |
| Delayed motor start (max) DC3σ | [1] [4] | 0.48 | 0.20 | 0.90 | 0.20 | 0.50 | 0.20 | 0.90 | 0.20 |
| Peak operating current<br>Typical DC$\overline{X}$<br>Maximum DC3σ<br>Maximum (Peak) 3σ | <br>[1] [6]<br>[1] | <br>0.75<br>0.81<br>1.5 | <br>0.76<br>0.95<br>2.5 | <br>1.05<br>1.21<br>2.0 | <br>0.76<br>0.95<br>2.5 | <br>0.72<br>0.81<br>1.5 | <br>0.73<br>0.85<br>2.3 | <br>0.91<br>1.21<br>2.0 | <br>0.73<br>0.85<br>2.3 |

**Notes.**

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

[2] A –10% droop is permissible during initial start of spindle, and must return to ±5% before 7,200 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] Operating condition is defined as random seek read operations with a block count of 64.

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 drive to ensure proper termination of the peripheral I/O cables. To automatically delay motor start based on the target ID (SCSI ID) enable the Delay Motor Start option and disable the Enable Motor Start option on the J2 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 J2 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:

T - 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 1 of Table 2.
T3 - The heads move from the landing zone to the data area.
T4 - The adaptive servo calibration sequence is performed.
T5 - 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.

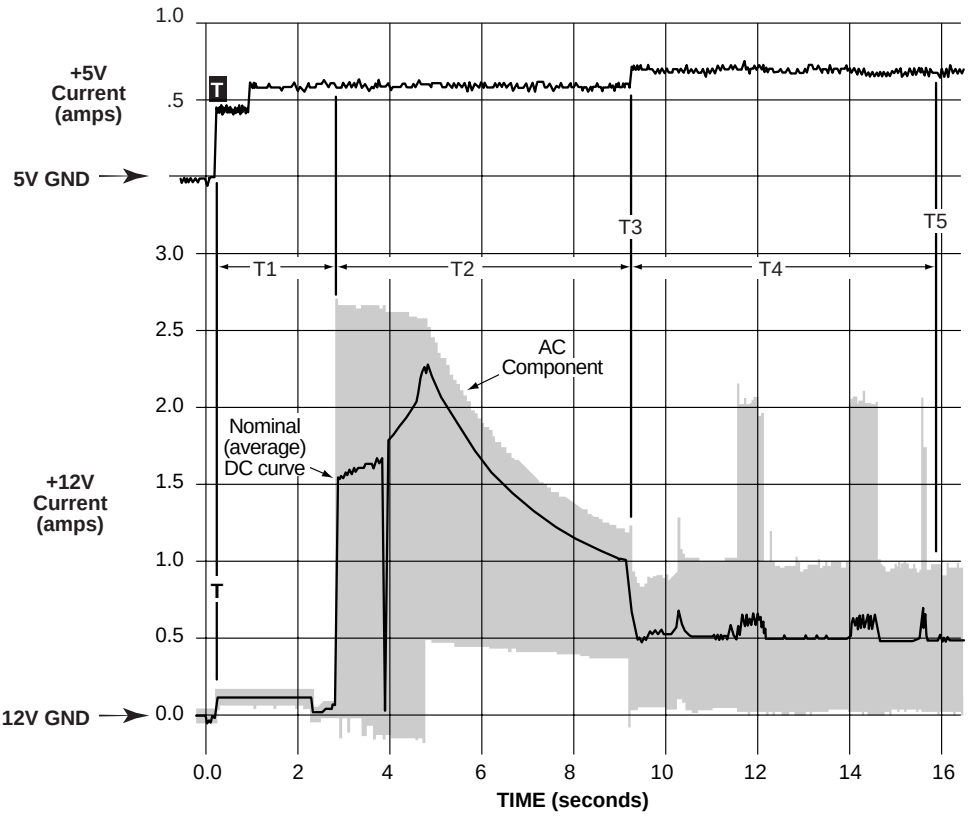



**Figure 3. Typical Barracuda 4XL family drive +5 V and +12 V current profile**

## 6.3 Power dissipation

### ST34572N/W/WC and ST32272N/W/WC

For drives with single ended interface circuits, typical operating random read power dissipation is 12.9 watts (44 BTUs per hour) of DC power average at nominal voltages. Typical power dissipation under idle conditions is 8.8 watts (30 BTUs per hour).

### ST34572WD/DC and ST32272WD/DC

For drives with differential interface circuits, typical operating random read power dissipation is 14.4 watts (49 BTUs per hour) of DC power average at nominal voltages. Typical power dissipation under idle conditions is 10 watts (34 BTUs per hour).

## 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 temperature 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 [3] above these values may adversely affect the drives ability to meet specifications.

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

To confirm that the required cooling for the Barracuda electronics and HDA is provided, place the drive in its final mechanical configuration, perform random write/read operations. After the temperatures stabilize, measure the case temperature of the components listed in Table 3.

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**

| Items in Figure 4 | Column 1 maximum case temperatures operating (50°C ambient) [1] | Column 2 Maximum allowable case temperature to meet MTBF spec. |
|---|---|---|
| HDA [2] | 140°F (60°C) | 113°F (45°C) |
| U2 [3] | 178°F (81°C) | 142°F (61°C) |
| U4 [3] | 183°F (84°C) | 147°F (64°C) |
| U5 [3] | 194°F (90°C) | 158°F (70°C) |
| U13 [3] | 174°F (79°C) | 138°F (59°C) |

**Note.**

[1] 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.

[2] Measure HDA temp at point labeled “HDA” on Figure 4.

[3] PCB mounted integrated circuit case.

b. Non-operating

–40° to 158°F (–40° to 70°C) package ambient with a maximum gradient of 45°F (25°C) per hour. This specification assumes that the drive is packaged in the shipping container designed by Seagate for use with drive.

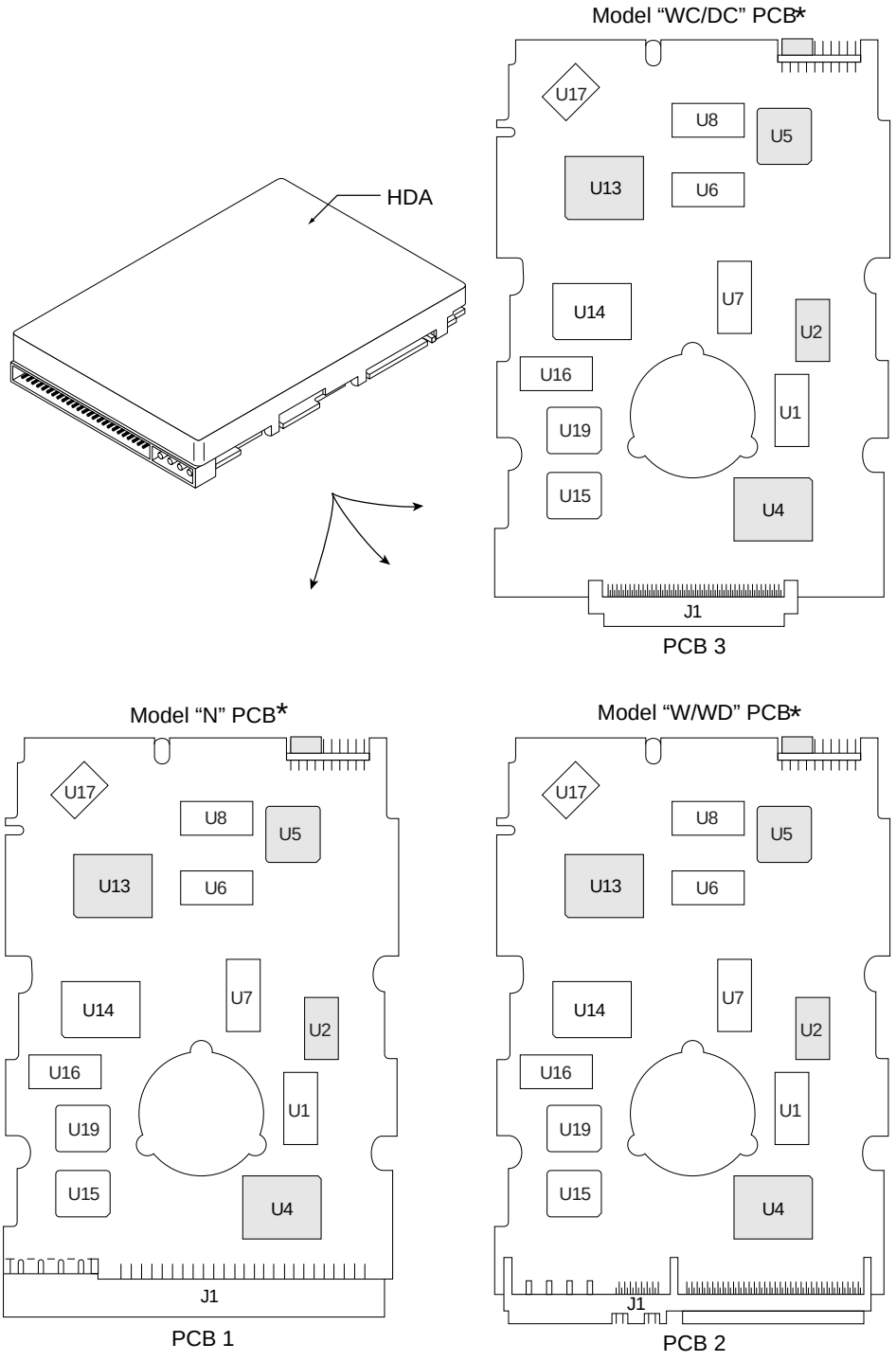



**Figure 4. Locations of printed circuit board (PCB) components listed in Table 3**

### 6.4.2 Relative humidity

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

a. Operating

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

b. Non-operating

5% to 95% relative humidity.

### 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 chassis. 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, shall operate error free while subjected to intermittent shock not exceeding 2 g at a maximum duration of 11 ms (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 10 g at a maximum duration of 11 ms (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 shall apply to all conditions of handling and transportation. This includes both isolated drives and integrated drives.

The drive subjected to nonrepetitive shock not exceeding 75 g at a maximum duration of 11 ms (half sinewave) shall not exhibit device damage or performance degradation. Shock may be applied in the X, Y, or Z axis.

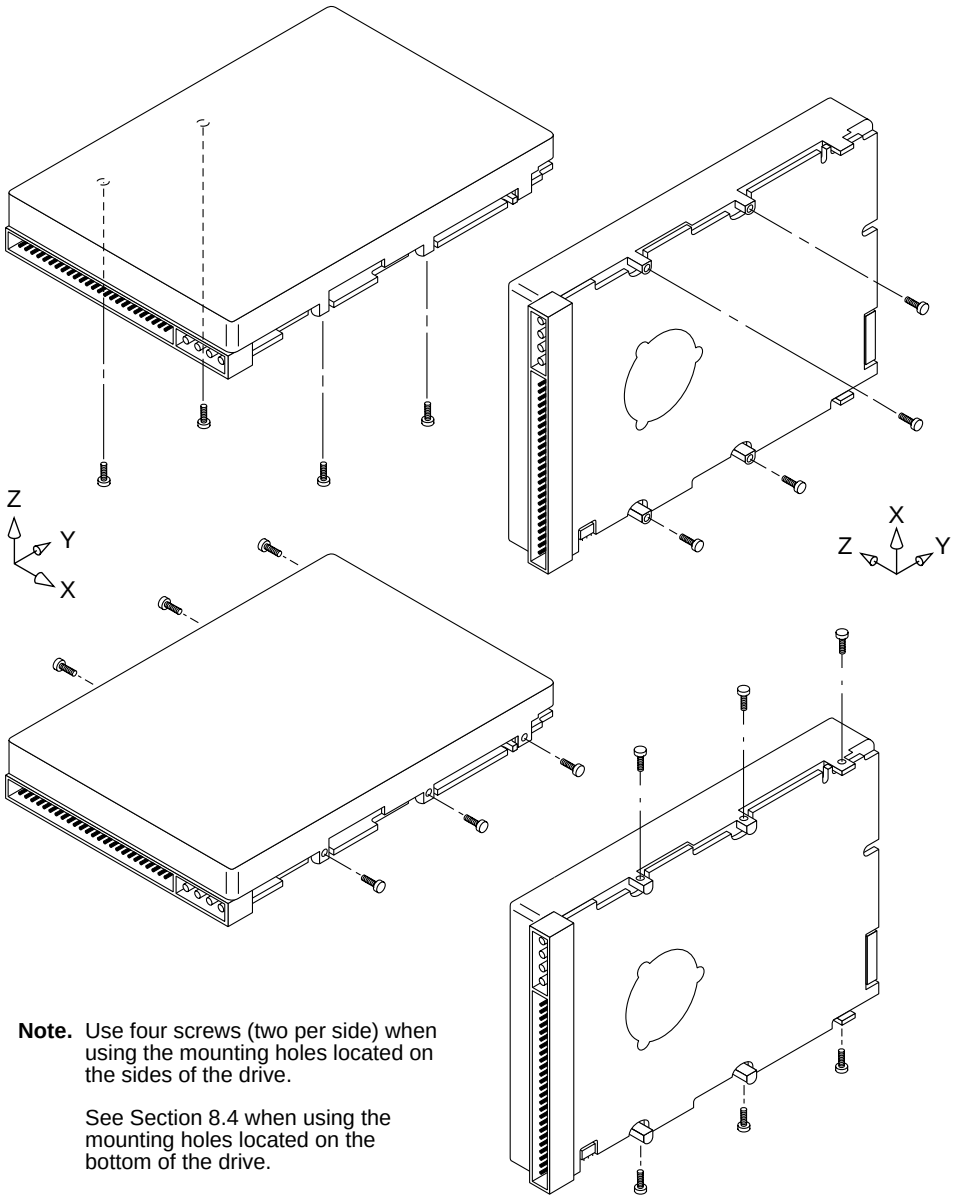
The drive subjected to nonrepetitive shock not exceeding 100 g at a maximum duration of 2 msec (half sinewave) does not exhibit device damage or performance degradation. Shock may be applied in the X, Y, or Z axis.

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 (1524 mm) |

| Package size | Packaged/product weight | Drop height |
|---|---|---|
| 600-1800 cu in (9,800-19,700 cu cm) | 0-20 lb (0 to 9.1 kg) | 48 in (1219 mm) |
| >1800 cu in (>19,700 cu cm) | 0-20 lb (0 to 9.1 kg) | 42 in (1067 mm) |
| >600 cu in (>9,800 cu cm) | 20-40 lb (9.1 to 18.1 kg) | 36 in (914 mm) |




**Note.** Use four screws (two per side) when using the mounting holes located on the sides of the drive.

See Section 8.4 when using the mounting holes located on the bottom of the drive.

**Figure 5. Recommended mounting**

#### 6.4.4.2 Vibration

a. Operating - normal

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

5-350 Hz @ 0.5 g

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

b. Operating - abnormal

5-350 Hz @ 0.75 g (X, Y, or Z axis)

c. Non-operating

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

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

5-22 Hz @ 0.081 inches (2.05 mm) displacement

22-350 Hz @ 2.00 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 mode shall be 4.2 bels typical when measured to Seagate's 30553-001 specification.

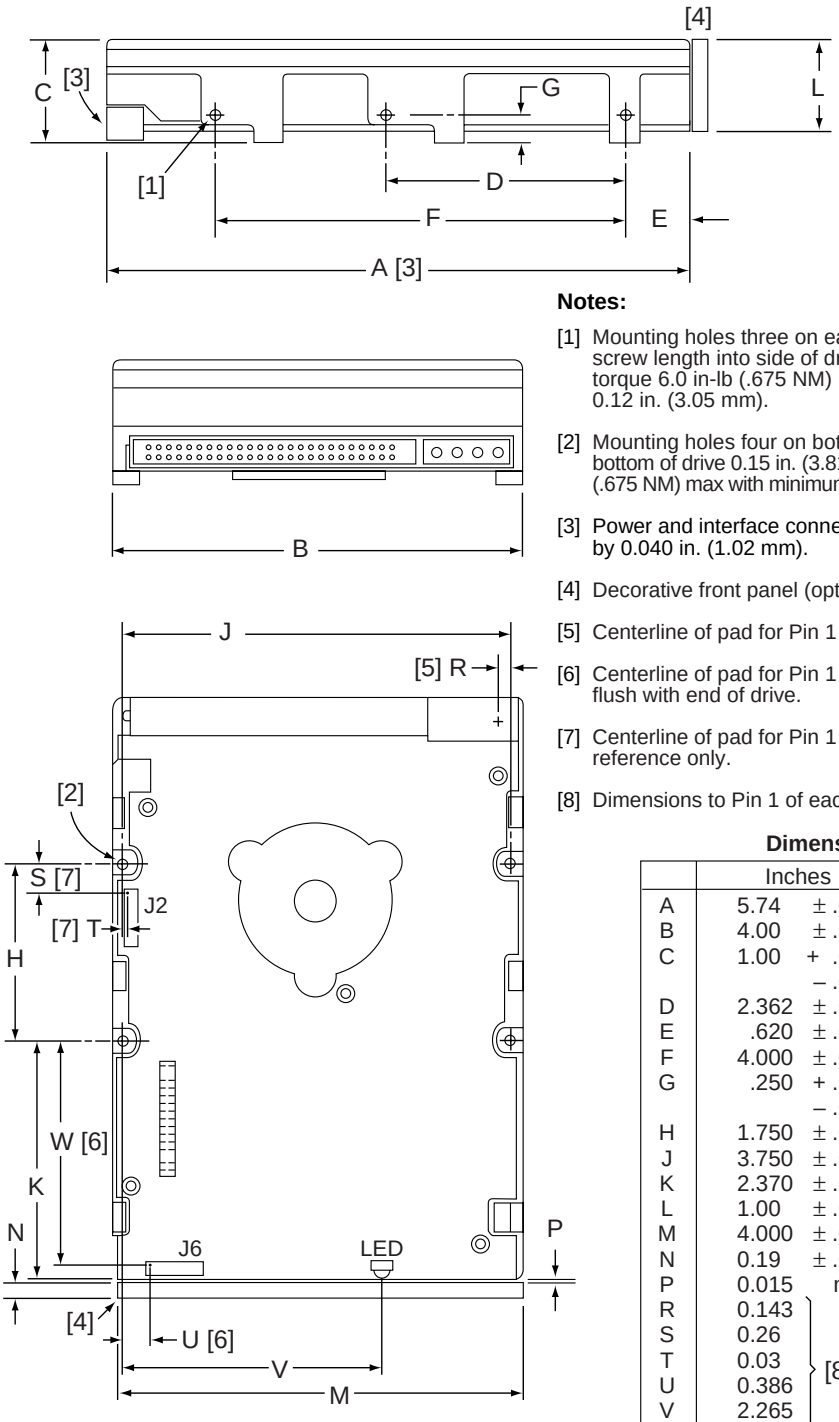
### 6.4.7 Electromagnetic susceptibility

See Section 2.1.2.

## 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 figure below. Refer to Figures 6, 7, and 8 for detailed mounting configuration dimensions. See Section 8.4, “Drive mounting.”

| | | | |
|---|---|---|---|
| Height: | 1.00 in | 25.4 | mm |
| Width: | 4.00 in | 101.6 | mm |
| Depth: | 5.74 in | 145.8 | mm |
| Weight: | 1.5 pounds | 0.68 | kilograms |




**Notes:**

[1] Mounting holes three on each side, 6-32 UNC. Max screw length into side of drive 0.15 in. (3.81 mm). Screw tightening torque 6.0 in-lb (.675 NM) max with minimum thread engagement of 0.12 in. (3.05 mm).

[2] Mounting holes four on bottom, 6-32 UNC. Max screw length into bottom of drive 0.15 in. (3.81 mm). Screw tightening torque 6.0 in-lb (.675 NM) max with minimum thread engagement of 0.12 in. (3.05 mm).

[3] Power and interface connectors can extend past the “A” dimension by 0.040 in. (1.02 mm).

[4] Decorative front panel (optional).

[5] Centerline of pad for Pin 1 of power connector.

[6] Centerline of pad for Pin 1 of J6. Pin ends on J6 are nominally flush with end of drive.

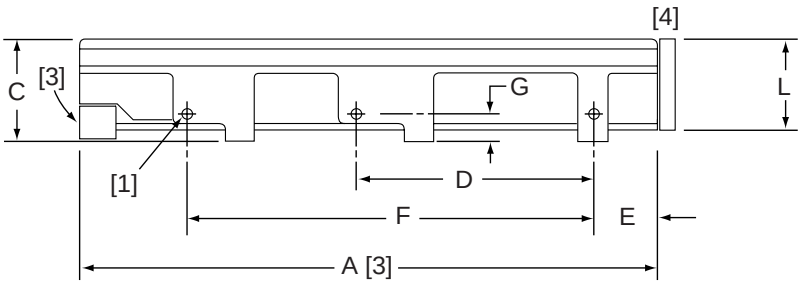
[7] Centerline of pad for Pin 1 of J2. Dimensions indicated are for reference only.

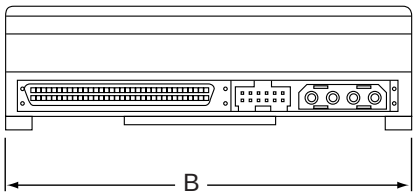
[8] Dimensions to Pin 1 of each connector are nominal values.

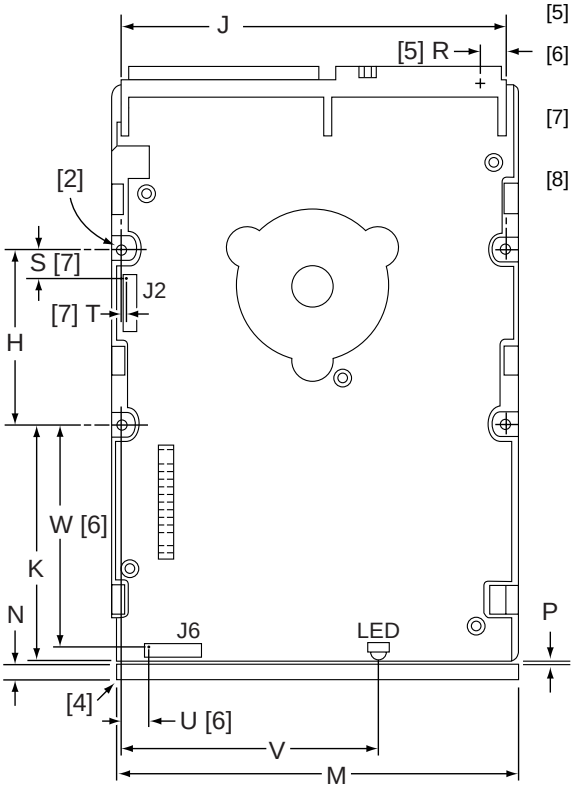
**Dimension Table**

| | Inches | Millimeters |
|---|---|---|
| A | 5.74 ± .010 | 145.80 ± .25 |
| B | 4.00 ± .010 | 101.60 ± .25 |
| C | 1.00 + .021 – .009 | 25.40 + .53 – .22 |
| D | 2.362 ± .010 | 60.00 ± .25 |
| E | .620 ± .020 | 15.75 ± .50 |
| F | 4.000 ± .010 | 101.60 ± .25 |
| G | .250 + .010 – .005 | 6.35 + .25 – .12 |
| H | 1.750 ± .010 | 44.45 ± .25 |
| J | 3.750 ± .010 | 95.25 ± .25 |
| K | 2.370 ± .020 | 60.20 ± .50 |
| L | 1.00 ± .010 | 25.4 ± .25 |
| M | 4.000 ± .010 | 101.6 ± .25 |
| N | 0.19 ± .010 | 4.83 ± .25 |
| P | 0.015 max | 0.381 max |
| R | 0.143 [8] | 3.63 [8] |
| S | 0.26 | 6.60 |
| T | 0.03 | 0.76 |
| U | 0.386 | 9.80 |
| V | 2.265 | 57.53 |
| W | 2.075 | 52.71 |

**Figure 6. Mounting configuration dimensions for models “N”**




**Notes:**

[1] Mounting holes three on each side, 6-32 UNC. Max screw length into side of drive 0.15 in. (3.81 mm). Screw tightening torque 6.0 in-lb (.675 NM) max with minimum thread engagement of 0.12 in. (3.05 mm).

[2] Mounting holes four on bottom, 6-32 UNC. Max screw length into bottom of drive 0.15 in. (3.81 mm). Screw tightening torque 6.0 in-lb (.675 NM) max with minimum thread engagement of 0.12 in. (3.05 mm).

[3] Power and interface connectors can extend past the “A” dimension by 0.040 in. (1.02 mm).

[4] Decorative front panel (optional).

[5] Centerline of pad for Pin 1 of power connector.

[6] Centerline of pad for Pin 1 of J6. Pin ends on J6 are nominally flush with end of drive.

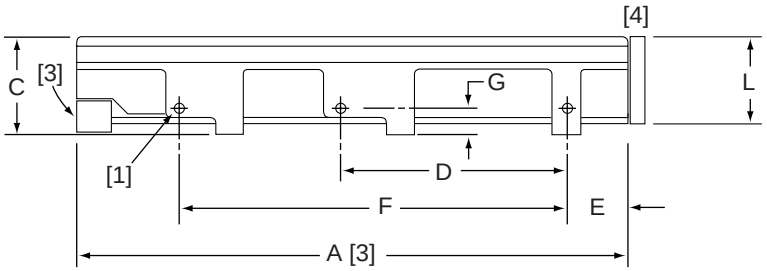
[7] Centerline of pad for Pin 1 of J2. Dimensions indicated are for reference only.

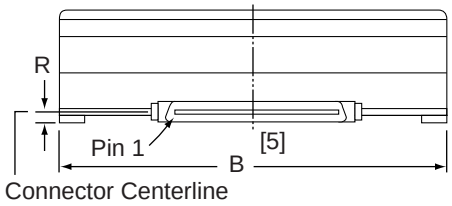
[8] Dimensions to Pin 1 of each connector are nominal values.

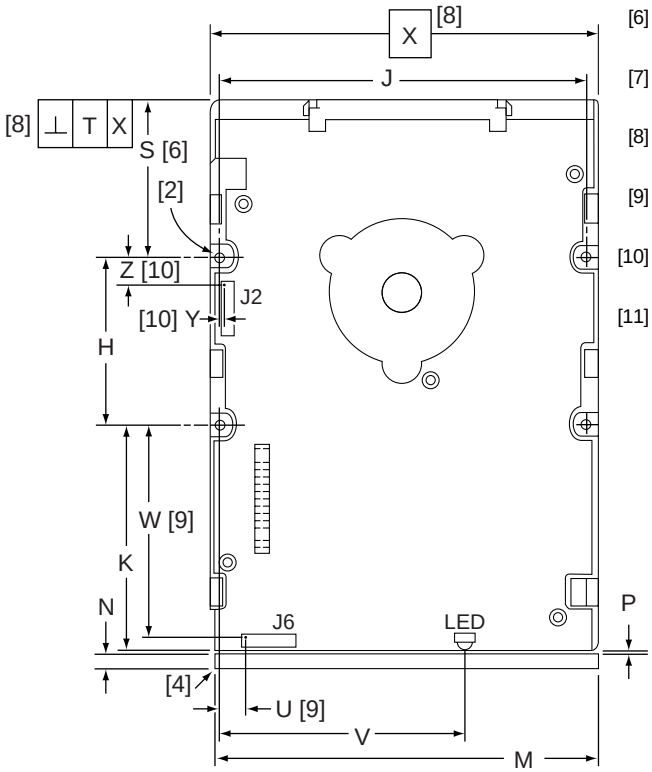
**Dimension Table**

| | Inches | Millimeters |
|---|---|---|
| A | 5.74 ± .010 | 145.80 ± .25 |
| B | 4.00 ± .010 | 101.60 ± .25 |
| C | 1.00 + .021 – .009 | 25.40 + .53 – .22 |
| D | 2.362 ± .010 | 60.00 ± .25 |
| E | .620 ± .020 | 15.75 ± .50 |
| F | 4.000 ± .010 | 101.60 ± .25 |
| G | .250 + .010 – .005 | 6.35 + .25 – .12 |
| H | 1.750 ± .010 | 44.45 ± .25 |
| J | 3.750 ± .010 | 95.25 ± .25 |
| K | 2.370 ± .020 | 60.20 ± .50 |
| L | 1.00 ± .010 | 25.4 ± .25 |
| M | 4.000 ± .010 | 101.6 ± .25 |
| N | 0.19 ± .010 | 4.83 ± .25 |
| P | 0.015 max | 0.381 max |
| R | 0.143 | 3.63 |
| S | 0.26 | 6.60 |
| T | 0.03 [8] | 0.76 [8] |
| U | 0.386 | 9.80 |
| V | 2.265 | 57.53 |
| W | 2.075 | 52.71 |

**Figure 7. Mounting configuration dimensions for models “W” and “WD”**




**Notes:**

[1] Mounting holes three on each side, 6-32 UNC. Max screw length into side of drive 0.15 in. (3.81 mm). Screw tightening torque 6.0 in-lb (.675 NM) max with minimum thread engagement of 0.12 in. (3.05 mm).

[2] Mounting holes four on bottom, 6-32 UNC. Max screw length into bottom of drive 0.15 in. (3.81 mm). Screw tightening torque 6.0 in-lb (.675 NM) max with minimum thread engagement of 0.12 in. (3.05 mm).

[3] Interface connector is flush with the end of drive within ±0.020 in. (.5 mm). The interface connector location may extend beyond HDA dimension "A" by 0.020 in. (.5 mm).

[4] Decorative front panel (optional).

[5] Connector J1 is centered (side to side) on drive within ±0.020 in. (.508 mm).

[6] Dimension "S" is from bottom rear drive mounting holes center(s) to the face of the connector at the center of the drive.

[7] Dimensions "S" and "T" are unique requirements for SCA drives only, required for conformance with latest ANSI SFF Spec #8337.

[8] Maximum connector non-perpendicularity to side planes pointed to by X.

[9] Centerline of pad for Pin 1 of J6. Pin ends on J6 are nominally flush with end of drive.

[10] Centerline of pad for Pin 1 of J2. Dimensions indicated are for reference only.

[11] Dimensions to Pin 1 of each connector are nominal values.

**Dimension Table**

| | | Inches | Millimeters |
|---|---|---|---|
| | A | 5.74 ± .010 | 145.80 ± .25 |
| | B | 4.00 ± .010 | 101.60 ± .25 |
| | C | 1.00 + .021 – .009 | 25.40 + .53 – .22 |
| | D | 2.362 ± .010 | 60.00 ± .25 |
| | E | .620 ± .020 | 15.75 ± .50 |
| | F | 4.000 ± .010 | 101.60 ± .25 |
| | G | .250 + .010 – .005 | 6.35 + .25 – .12 |
| | H | 1.750 ± .010 | 44.45 ± .25 |
| | J | 3.750 ± .010 | 95.25 ± .25 |
| | K | 2.370 ± .020 | 60.20 ± .50 |
| | L | 1.00 ± .010 | 25.4 ± .25 |
| | M | 4.000 ± .010 | 101.6 ± .25 |
| | N | 0.19 ± .010 | 4.83 ± .25 |
| | P | 0.015 max | 0.381 max |
| | R | 0.181 + .015 – .010 | 4.597 + .38 – .25 |
| [7] | S | 1.62 ± .02 | 41.15 ± .50 |
| [8] | T | .015 | .38 |
| [11] | U | 0.386 | 9.80 |
| [11] | V | 2.265 | 57.53 |
| [11] | W | 2.075 | 52.71 |
| [11] | Y | 0.03 | 0.76 |
| [11] | Z | 0.26 | 0.60 |

**Figure 8. Mounting configuration dimensions for models “WC” and “DC”**

# 7.0 Defect and error management

The drive, as delivered, complies with this specification. The read error rate and specified storage capacity are not dependent upon use of 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). Tools for use in designing a defect/error management plan are briefly outlined in this section, with references to other sections where further details are given.

## 7.1 Drive internal defects and errors

Identified defects are recorded on the drive defects list tracks (referred to as the primary or ETF defect list). These known defects are reallocated during the initial drive format operation at the factory. (See Section 5.2.1.2, “Format Unit command” in the *SCSI Interface Product Manual*, part number 77738479). Data correction by ECC will be applied to recover data from additional flaws if they occur.

Details of the SCSI commands supported by the drive are described in *SCSI Interface Product Manual*.

## 7.2 SCSI systems errors

Information on the reporting of operational errors or faults across the interface is given in the SCSI Interface Product Manual. Message Protocol System is described in the *SCSI Interface Product Manual*. Several of the messages are used in the SCSI systems error management system. The Request Sense command returns information to the host about numerous kinds of errors or faults. The Receive Diagnostic Results reports the results of diagnostic operations performed by the drive.

Status returned by the drive to the Initiator is described in the *SCSI Interface Product Manual*. Status reporting plays a role in the SCSI systems error management and its use in that respect is described in sections where the various commands are discussed.

# 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 connector J2 on the PCB (or J1-Auxiliary on the "W" models), or via the drive to host I/O signals on "WC" models. Some users connect cables to J6 or J1-Auxiliary 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 need to set the drive ID using the ID jumpers.

### Configure drive options

For option jumper locations and definitions refer to Figures 9, 10, 11, 12, and 13. 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 "WC", "WD," and "DC" 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 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 format 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 FAT 32) or later do not need to partition the drive.

## 8.1 Drive ID/option select header

Figures 9 through 11 show views of the drive ID select jumper connectors. Figure 12 shows the option select jumper connector for all models. Figure 10 shows a rear view of model drives for the purpose of showing J1-auxiliary of the drive. Both J1-auxiliary and J6 have pins for selecting drive ID and for connecting the remote LED cable. Only one or the other should be used, although using both at the same time would not damage the drive. The notes following the figures describe the functions of the various jumper positions on the connectors J2, J1-Auxiliary and J6. Suggested part number for the jumpers used on J2 is Molex 52747-0211(Seagate P/N 77679052). Suggested part number for the jumpers used on J1-Auxiliary and J6 are Method Electronics 861M-202-70 (Seagate part number 15481851). A bag with the two jumper plug types is shipped with standard OEM drives.

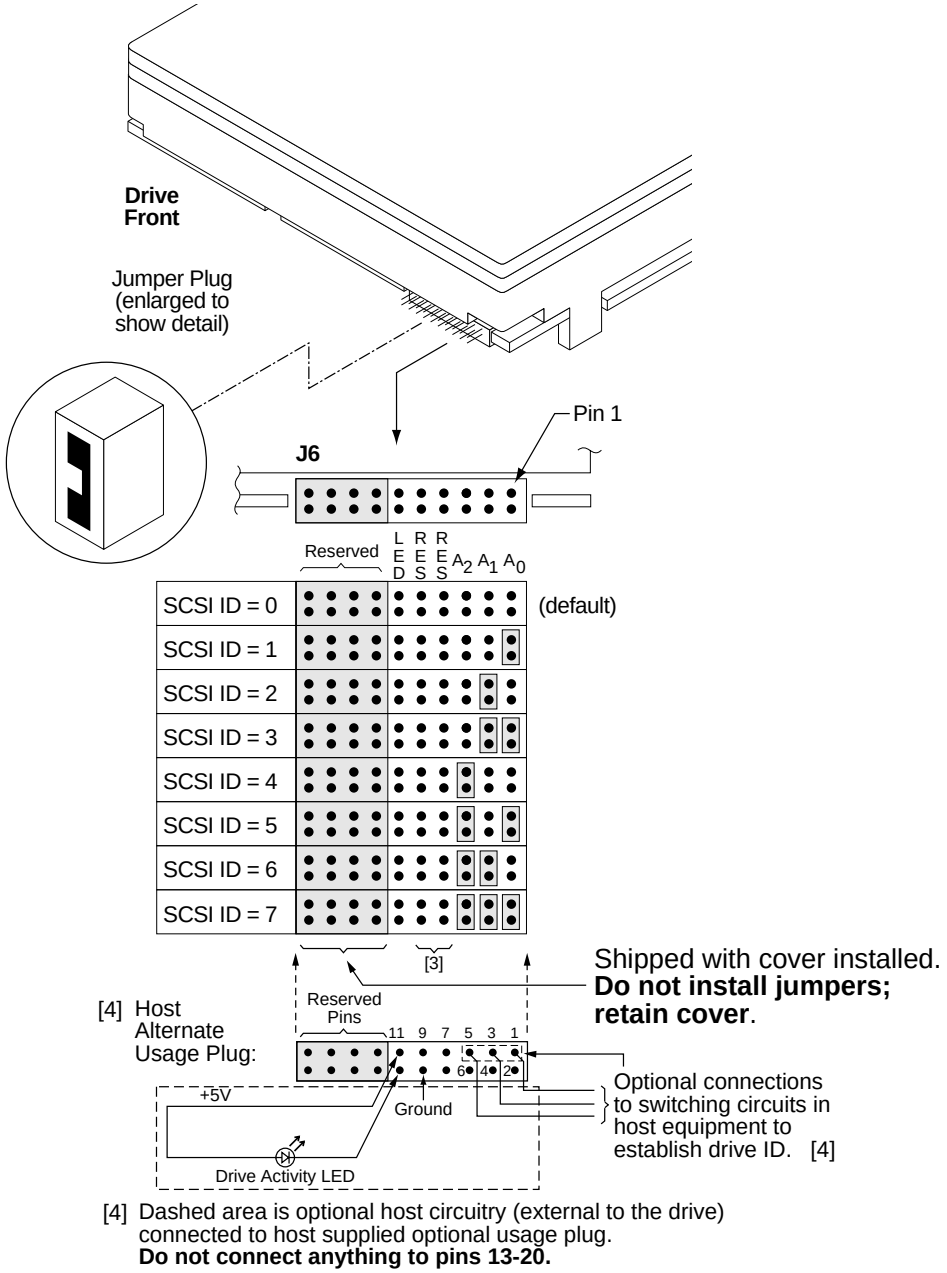
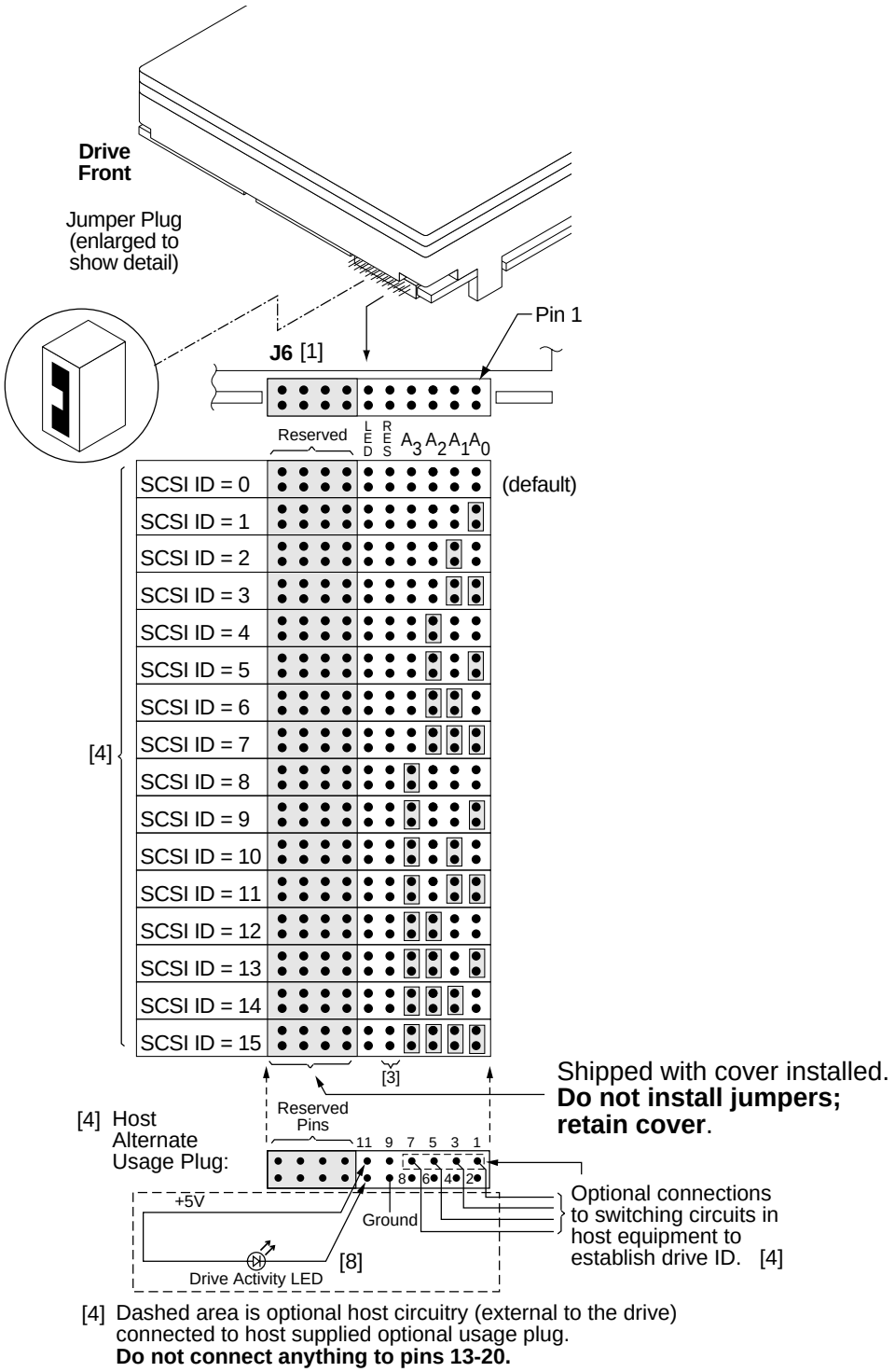



**Figure 9. Barracuda 4XL family drive ID select header for models "N"**

Notes for Figures 9 through 13 are in Section 8.1.1.




[4] Dashed area is optional host circuitry (external to the drive) connected to host supplied optional usage plug.
**Do not connect anything to pins 13-20.**

**Figure 10. Barracuda 4XL family drive ID select for models “W,” “WC,” “WD,” and “DC”**

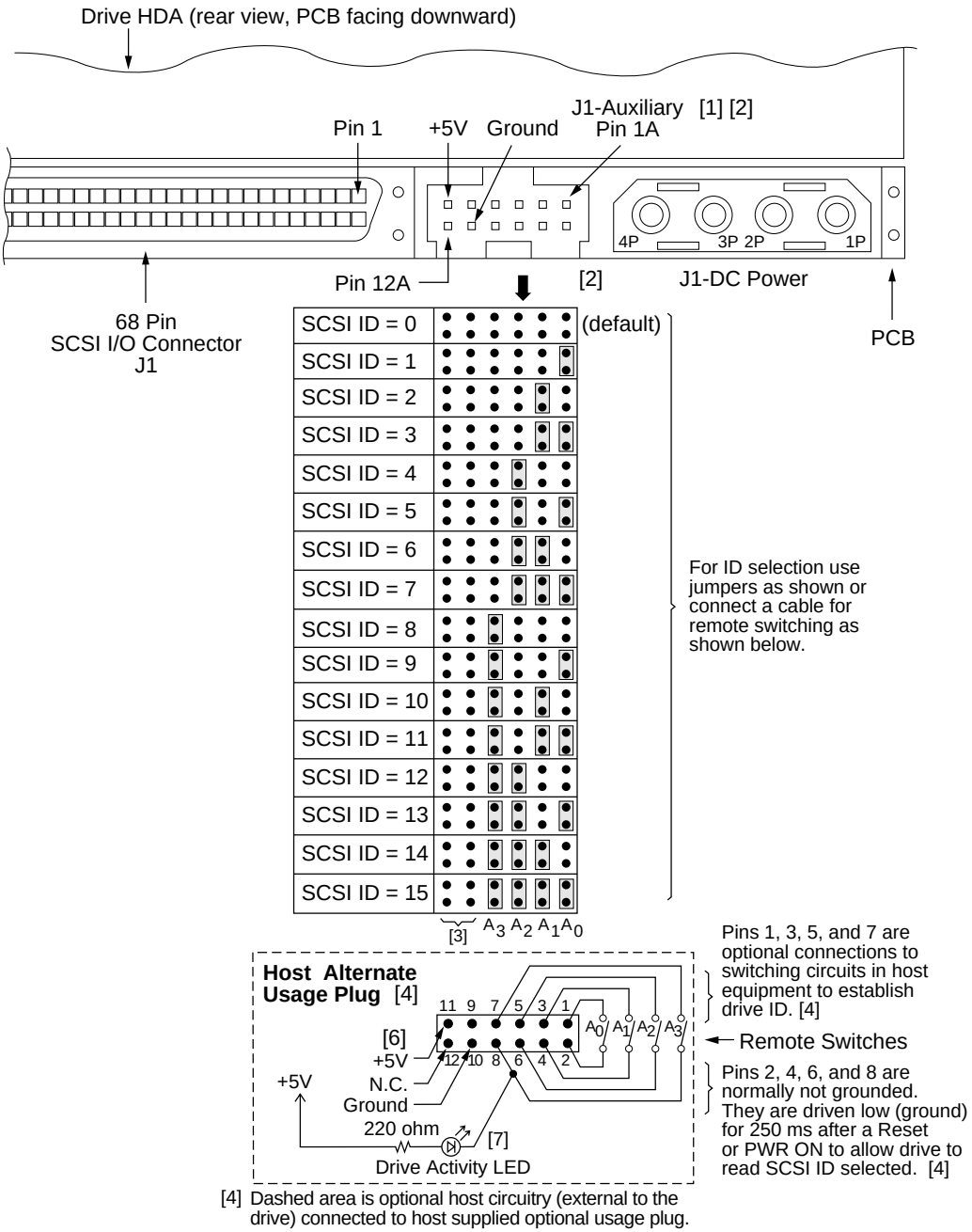



**Figure 11. Barracuda 4XL family drive ID select header J1-auxiliary for models “W” and “WD” (J1-Auxiliary Pins 1A - 12A)**

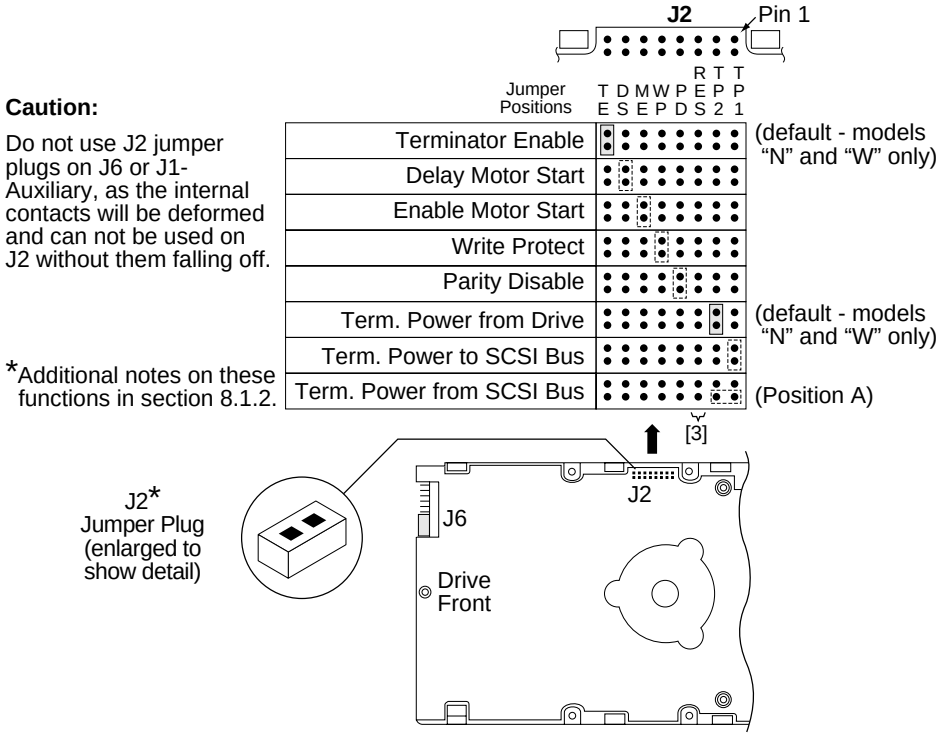



**Figure 12. Barracuda 4XL family drive option select header for models "N," "W," and "WD"**

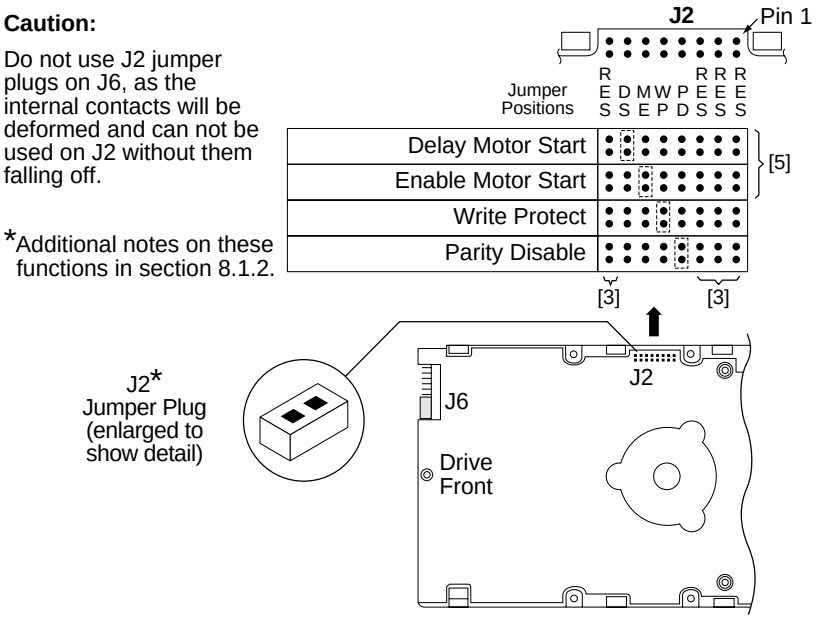



**Figure 13. Barracuda 4XL family drive option select header for models "WC" and "DC"**

### 8.1.1 Notes for Figures 9, 10, 11, 12, and 13.

[1] Notes explaining the functions of the various jumpers on jumper header connectors J2, J1-Auxiliary and J6 are given here and in Section 8.1.2. 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.

[2] The PCB on "N," "WC," and "DC" model drives does not have connector J1-Auxiliary. The J1-Auxiliary connector signals conform to SFF-8009 Revision 2.0, Unitized Connector for Cabled Drives, signal assignments for auxiliary connectors. See note [4].

[3] Reserved useage. Do not install any jumpers.

[4] Table 4 summarizes the configuration selection possibilities available on the different Barracuda 4XL model drives.

[5] These signals are also on 80 pin J1. See Tables 16 and 17.

[6] Voltage supplied by the drive.

[7] J1A Drive Activity LED—with series resistor built-in pin 12, is the open collector driver that drives the external LED minus side low to turn it on. This output is capable of driving > 20mA. This is the same signal as on J6 pin 12, except J1A pin 8 goes through a 220 Ohm resistor. Tie the minus side of the external LED to this pin.

[8] J6 Drive Activity LED—without series resistor built-in pin 8, is the open collector driver that drives the external LED minus side low to turn it on. This output is capable of driving > 20mA. This is the same signal as on J1A pin 8, except J6 pin 12 does not go through a 220 Ohm resistor. Tie the minus side of the external LED to this pin.

**Table 4: Drive configuration selections summary**

| Interface type | Function | Connector | | | | Applicable figure |
|---|---|---|---|---|---|---|
| | | J1 | J6 | J1-AUX | J2 | |
| N | Drive ID | | X, Y | none | | 9 |
| N | Drive Activity LED | | Y [c] | none | | 9 |
| N | Option select | | | none | X | 12 |
| W, WD | Drive ID | | X, Y | X, Y [e] | | 10, 11 [a] |
| W, WD | Drive Activity LED | | Y [c] | Y [c] | | 10, 11 [a] |
| W, WD | Option select | | | | X | 12 |
| WC, DC | Drive ID | Y[f] | X, Y | none | | 10 [d] |
| WC, DC | Drive Activity LED | Y[b][c] | Y [c] | none | | 10 [d] |
| WC, DC | Option select: | | | | | |
| | Delayed Mtr Start | Y[b] | | none | X | 13 |
| | Enable Mtr Start | Y[b] | | none | X | 13 |
| | Write Protect | | | none | X | 13 |
| | Parity Disable | | | none | X | 13 |

("X" means the function selection can be made with jumpers on that connector;
"Y" means the signal is available to host through that connector.)

**Notes for Table 4 [ ]:**

[a] Use either J6 or J1-Aux, but not both.

[b] I/O connector J1 plugs directly into host. No jumper can be installed on J1. The host supplies the logic state of these function signals causing the selection of these functions. See pinout Table 16.

[c] The host can drive a remotely located Drive Activity LED using signal.

[d] Use either J1 or J6, but not both.

[e] The drive reads the ID (asserted low) from J1-Auxiliary pins 1, 3, 5 and 7 for 250 ms after power-on or drive reset. Jumper plugs can be used on J1-Auxiliary pins 1-2, 3-4, 5-6 and 7-8 to set drive ID if desired, but usually a connector/cable is plugged to J1-Auxiliary to run these signals to the host for remote ID selection.

[f] The host selects drive ID through J1.

### 8.1.2 Function description

| J2 Jumper Installation | | Jumper Function Description |
|---|---|---|
| **TE** | | **(Applies only to "N" and "W" models)** |
| On | | With the jumper installed, the On-board (non-removable) terminator circuits are enabled (connected to the I/O lines). **Default** is jumper installed. |
| Off | | Terminator circuits not enabled (not connected to I/O lines). |
| **DS** | **ME** | **(Applies to all models)** |
| Off | Off | Spindle starts immediately after power up - **Default** setting. |
| Off | On | Drive spindle does not start until Start Unit command received from host. |
| On | Off | Spindle Startup is delayed by SCSI ID times 12 seconds after power is applied, i.e., drive 0 spindle starts immediately when DC power connected, drive 1 starts after 12 second delay, drive 2 starts after 24 second delay, etc. |
| On | On | Drive spindle starts when Start Unit command received from host. Delayed start feature is overridden and does not apply when **ME** jumper is installed. |
| **WP** | | **(Applies to all models)** |
| On | | Entire drive is write protected. |
| Off | | Drive is not write protected. **Default** is no **WP** jumper installed. |
| **PD** | | **(Applies to all models)** |
| On | | Parity checking and parity error reporting by the drive is disabled. |
| Off | | Drive checks for parity and reports result of parity checking to host. **Default** is **PD** jumper not installed. |
| **RES** | | **(Applies to all models)** |
| Off | | Reserved jumper position. Default is no jumper installed. |
| **TP2** | **TP1** | **(Does not apply to "WC" or "DC" models)** |
| Off | Off | No terminator power is connected to drive terminators or SCSI bus I/O cable*. |
| On | Off | Drive supplies its own terminator power only. Jumper on this position is factory **default**. |
| Off | On | Drive supplies power to SCSI bus I/O cable*; none to internal terminators. When drives have differential I/O circuits, a jumper on the **TP1** position may be needed to power external terminators (see system documentation). The "WD" drives have differential I/O circuits which have no terminator circuits on the drive. |
| On | On | Drive supplies terminator power to itself (internal connection) and to SCSI bus I/O cable*. This is a legal jumper setting. |
| **TP1 and TP2 "Position A"** | | **(Applies only to "N" and "W")** |
| On | | This horizontally positioned jumper across the two **TP** positions furthest from the PCB edge, connects terminator power from SCSI bus I/O Termpower cable* to the drive's internal terminators (for single-ended I/O only). |
| Off | | See above explanations for **TP** jumpers. |

*See Figure 12 for 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

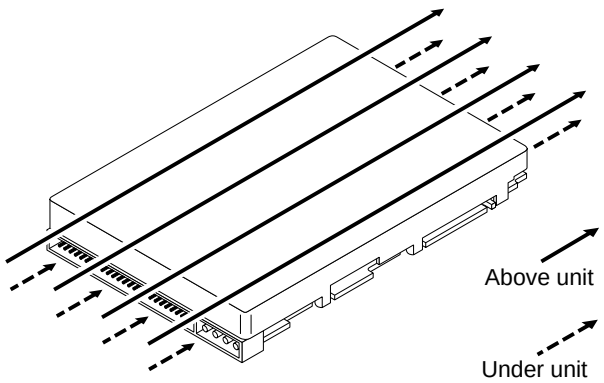
Cabinet cooling must be designed by the customer so that the ambient temperature immediately surrounding the drive will not exceed temperature conditions specified in Section 6.4.1, “Temperature.” Specific consideration should be given to make sure adequate air circulation is present around the printed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

#### 8.3.1 Air flow

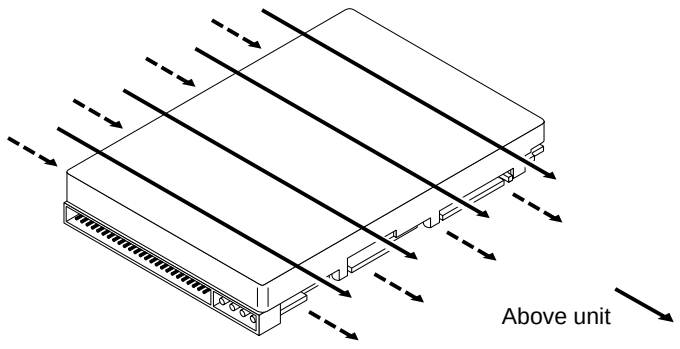
The rack, cabinet, or drawer environment for the Barracuda 4XL drive must provide heat removal from the electronics and head and disc assembly (HDA). You should confirm that adequate heat removal is provided using the temperature measurement guidelines described in Section 6.4.1.

Forced air flow may be required to keep temperatures at or below the specified case temperatures of Table 3, Column 2, in which case 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.

If forced air is determined to be necessary, possible air-flow patterns are shown in Figure 14. The air-flow patterns are created by one or more fans, either forcing or drawing air as shown in the illustrations. Conduction, convection, or other forced air-flow patterns are acceptable as long as the temperature measurement guidelines of Section 6.4.1 are met.




**Note.** Air flows in the direction shown (front to back) or in reverse direction (back to front)




**Note.** Air flows in the direction shown or in reverse direction (side to side)

**Figure 14. Air flow (suggested)**

### 8.4 Drive mounting

Refer to Figure 5 on page 26 for an illustration of the recommended mounting orientations

When mounting the drive using the bottom holes (x-y plane in Figure 5) care must be taken to ensure that the drive is not physically distorted due to a stiff non-flat mounting surface. The allowable mounting surface stiffness is 80 lb/in (14.0 N/mm). The following equation and paragraph define the allowable mounting surface stiffness:

$$K = \frac{F}{x} = 80\text{lb/in (14.0 N/mm)}$$

where ‘k’ represents the mounting surface stiffness (units of lb/in or N/mm), and ‘x’ represents the out-of-plane mounting surface distortion (units of inches or millimeters). The out-of-plane distortion (‘x’) is determined by defining a plane with three of the four mounting points fixed and evaluating the out-of-plane deflection of the fourth mounting point when a known force is applied to the fourth point.

**Note.** Before mounting the drive in any kind of 3.5-inch to 5.25-inch adapter frame, verify with Seagate Technology that the drive can meet the shock and vibration specifications given herein while mounted in such an adapter frame. Adapter frames that are available may not have a mechanical structure capable of mounting the drive so that it can meet the shock and vibration specifications listed in this manual.

### 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 it is desired for the system chassis to not be connected to the HDA/PCB ground, the systems integrator or user 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 Barracuda 4XL 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 Barracuda 4XL 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 Barracuda 4XL family drives.

**Table 5: SCSI messages supported by Barracuda 4XL family drives**

| Message name | Message code | Supported by SCSI-2/3 |
|---|---|---|
| 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 | Y |
| 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 | N |
| Wide data transfer request | [1] [2] | Y |

**Notes.**

[1] Extended messages (see *SCSI Interface Product Manual*, part number 77738479).

[2] Not applicable to “N” models.

### 9.3 SCSI interface commands supported

Table 6 following lists the SCSI interface commands that are supported in the SCSI-2, and SCSI-3 modes of the drive. Barracuda 4XL family drives can be changed back and forth between SCSI-1 and SCSI-2/SCSI-3 modes using the Change Definition command. OEM standard drives are shipped set to operate in SCSI-2/ SCSI-3 mode.

**Table 6: Commands supported by Barracuda 4XL 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 | | N |
| DCRT bit supported | | Y |
| STPF bit supported | | Y |
| IP bit supported | | Y |
| DSP bit supported | | Y |
| IMMED bit supported | | Y |
| VS (vendor specific) | | N |
| Inquiry | 12h | Y |
| Date code page (C1h) | | Y |
| Device Behavior page (C3h) | | Y |
| Firmware numbers page (C0h) | | Y |
| Implemented operating def page (81h) | | Y |
| Jumper settings page (C2h) | | Y |
| Supported Vital product data page (00h) | | 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 |
| Verify error counter page (05h) | | Y |
| Write error counter page (02h) | | Y |
| Mode select (same pages as Mode Sense command) | 15h | Y [2] |
| Mode select (10) | 55h | Y |
| Capacity Programming | | Y |

**Table 6: Commands supported by Barracuda 4XL family drive (Continued)**

| Command name | Command code | Supported by SCSI-2/3 |
|---|---|---|
| Mode sense | 1Ah | Y [2] |
| Caching parameters page (08h) | | Y |
| Control mode page (0Ah) | | Y |
| Disconnect/reconnect (02h) (DTDC, DIMM not used) | | Y |
| Error recovery page (01h) | | Y |
| Format page (03h) | | Y |
| Information exceptions control page (1Ch) | | Y |
| Notch and Partition Page (0Ch) | | N |
| 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) | | N |
| 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 part reserve | | Y |
| Extent reservation | | N |
| Rezero unit | 01h | Y |
| Search data equal | 31h | N |
| Search data high | 30h | N |
| Search data low | 32h | N |
| Seek | 0Bh | Y |

**Table 6: Commands supported by Barracuda 4XL family drive (Continued)**

| Command name | Command code | Supported by SCSI-2/3 |
|---|---|---|
| Seek extended | 2Bh | Y |
| Send diagnostics | 1Dh | Y |
| Supported diagnostics pages (00h) | | Y |
| Translate page (40h) | | Y |
| Set limits | 33h | N |
| Start unit/stop unit (spindle ceases rotating) (1CH) | 1Bh | Y |
| Synchronize cache | 35h | Y |
| Test unit ready | 00h | Y |
| Verify | 2Fh | Y |
| BYTCHK bit supported | | Y |
| Write | 0Ah | Y |
| Write and verify | 2Eh | Y |
| DPO bit supported | | Y |
| FUA bit supported | | Y |
| Write buffer (modes 0, 2, supported) | 3Bh | Y |
| Firmware download option (modes 5, 7 supported) [3] | | Y |
| Write extended | 2Ah | Y |
| DPO bit supported | | Y |
| FUA bit support | | Y |
| Write long | 3Fh | Y |
| Write same | 41h | Y |
| XDRead | 52h | N |
| XDWrite | 50h | N |
| XDWrite extended | 80h | N |
| XPWrite | 51h | N |

[1] The drive can format to any even number of bytes per sector from 180 to 4,096.

[2] Tables 8 and 9 show how individual bits are set and which are changeable by the host.

[3] **WARNING:** A power loss during flash programming can result in firmware corruption. This usually makes the drive inoperable.

Table 7 lists the Standard Inquiry command data that the drive should return to the initiator per the format given in the *SCSI Interface Manual* (part number 77738479), section 5.1.1.3.

**Table 7: Barracuda 4XL family drive Standard Inquiry data**

| Bytes | Data (HEX) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0-15 | 00 | 00 | [02][1] | [02][2] | 8F | 00 | [00][6] | [1E][3] | 53 | 45 | 41 | 47 | 41 | 54 | 45 | 20 | VENDOR ID |
| 16-31 | 53 | 54 | [33] | [34] | [35] | [37] | [32] | [4E] | [00][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] | [37][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] 01 means SCSI-1 implemented;
02 means SCSI-2/SCSI-3 implemented. Default is 02.

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

[ ][3] For “N” models this value is 1E.
For “W,” “WD,” “WC,” and “DC” 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 22 reflect the drive’s model number in hex values. Bytes 23 and 24 reflect the drive’s interface type as follows:

| Model | Inquiry Data | Byte 23 | Byte 24 |
|---|---|---|---|
| STxxxxxN | STxxxxxN | 4E | 00 |
| STxxxxxW | STxxxxxW | 57 | 00 |
| STxxxxxWC | STxxxxxWC | 57 | 43 |
| STxxxxxWD | STxxxxxWD | 57 | 44 |
| STxxxxxDC | STxxxxxDC | 44 | 43 |

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

[ ][6] For “N” models, this value is 00.

For models “W,” “WD,” “WC,” and “DC,” this value is 01.

### 9.3.1 Inquiry Vital Product data

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 Manual* (part number 77738479), section 5.1.1.3.1 lists the Vital Product Data pages 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. See “Changeable values” 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 row entitled “CHG”. These are hex numbers representing the changeable values for Mode page 01. Note that bytes 04, 05, 06, and 07 are not changeable, because those fields are all zeros. If some changeable code had a hex value EF, that equates to the binary pattern 1110 1111. If there is 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.

Though the drive always reports non-zero values in bytes 00 and 01, those particular bytes are never changeable.

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

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 for SCSI-2/SCSI-3 implementation. See the *SCSI Interface Product Manual*.

**Definitions:** SAV = Saved value
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, ST34572 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 | 9F | 00 | 10 | 08 | | | | | | | | | | | | | | | | | | | | |
| | 00 | 00 | 00 | 00 | 00 | 00 | 02 | 00 | | | | | | | | | | | | | | | | |
| Mode Page | <----------Mode Page Headers and Parameter Data Bytes----------> | | | | | | | | | | | | | | | | | | | | | | | |
| 01 SAV | 81 | 0A | C8 | 10 | 68 | 00 | 00 | 00 | 0C | 00 | FF | FF | | | | | | | | | | | | |
| 01 DEF | 81 | 0A | C8 | 10 | 68 | 00 | 00 | 00 | 0C | 00 | FF | FF | | | | | | | | | | | | |
| 01 CHG | 81 | 0A | FF | FF | 00 | 00 | 00 | 00 | FF | 00 | 00 | 00 | | | | | | | | | | | | |
| 02 SAV | 82 | 0E | 80 | 80 | 00 | 0A | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | | | | | | | | |
| 02 DEF | 82 | 0E | 80 | 80 | 00 | 0A | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | | | | | | | | |
| 02 CHG | 82 | 0E | FF | FF | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 87 | 00 | 00 | 00 | | | | | | | | |
| 03 SAV | 83 | 16 | 00 | 30 | 00 | 76 | 00 | 00 | 00 | 00 | 00 | B2 | 02 | 00 | 00 | 01 | 00 | 20 | 00 | 3C | 40 | 00 | 00 | 00 |
| 03 DEF | 83 | 16 | 00 | 30 | 00 | 76 | 00 | 00 | 00 | 00 | 00 | B2 | 02 | 00 | 00 | 01 | 00 | 20 | 00 | 3C | 40 | 00 | 00 | 00 |
| 03 CHG | 83 | 16 | 00 | 00 | FF | FF | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| 04 SAV | 84 | 16 | 00 | 18 | 9C | 08 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 1C | 3C | 00 | 00 |
| 04 DEF | 84 | 16 | 00 | 18 | 9C | 08 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 1C | 3C | 00 | 00 |
| 04 CHG | 84 | 16 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| 07 SAV | 87 | 0A | 00 | 11 | 68 | 00 | 00 | 00 | 00 | 00 | FF | FF | | | | | | | | | | | | |
| 07 DEF | 87 | 0A | 00 | 11 | 68 | 00 | 00 | 00 | 00 | 00 | FF | FF | | | | | | | | | | | | |
| 07 CHG | 87 | 0A | 0F | FF | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | | | | | | | | | | | | |
| 08 SAV | 88 | 12 | 14 | 00 | FF | FF | 00 | 00 | FF | FF | FF | FF | 80 | 03 | 00 | 00 | 00 | 00 | 00 | 00 | | | | |
| 08 DEF | 88 | 12 | 14 | 00 | FF | FF | 00 | 00 | FF | FF | FF | FF | 80 | 03 | 00 | 00 | 00 | 00 | 00 | 00 | | | | |
| 08 CHG | 88 | 12 | B5 | 00 | FF | FF | FF | FF | FF | FF | 00 | 00 | A0[1] | FF | 00 | 00 | 00 | 00 | 00 | 00 | | | | |
| 0A SAV | 8A | 0A | 02 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | | | | | | | | | | | | |
| 0A DEF | 8A | 0A | 02 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | | | | | | | | | | | | |
| 0A CHG | 8A | 0A | 03 | F3 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | | | | | | | | | | | | |
| 1A SAV | 9A | 0A | 00 | 02 | 00 | 00 | 00 | 01 | 00 | 00 | 00 | 04 | | | | | | | | | | | | |
| 1A DEF | 9A | 0A | 00 | 02 | 00 | 00 | 00 | 01 | 00 | 00 | 00 | 04 | | | | | | | | | | | | |
| 1A CHG | 9A | 0A | 00 | 03 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | | | | | | | | | | | | |
| 1C SAV | 9C | 0A | 00 | 04 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 01 | | | | | | | | | | | | |
| 1C DEF | 9C | 0A | 00 | 04 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 01 | | | | | | | | | | | | |
| 1C CHG | 9C | 0A | 0C | 0F | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | | | | | | | | | | | | |
| 00 SAV | 80 | 02 | 00 | 00 | | | | | | | | | | | | | | | | | | | | |
| 00 DEF | 80 | 02 | 00 | 00 | | | | | | | | | | | | | | | | | | | | |
| 00 CHG | 80 | 02 | 77 | 00 | | | | | | | | | | | | | | | | | | | | |

[1] Though byte 12, bit 7 (A0) is shown as changeable, the FSW function governed by that bit is not implemented by this drive.

**Table 9: Mode sense data, ST32272 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 | 97 | 00 | 10 | 08 | | | | | | | | | | | | | | | | | | | | |
| | 00 | 00 | 00 | 00 | 00 | 00 | 02 | 00 | | | | | | | | | | | | | | | | |
| Mode Page | <----------Mode Page Headers and Parameter Data Bytes----------> | | | | | | | | | | | | | | | | | | | | | | | |
| 01 SAV | 81 | 0A | C8 | 10 | 68 | 00 | 00 | 00 | 0C | 00 | FF | FF | | | | | | | | | | | | |
| 01 DEF | 81 | 0A | C8 | 10 | 68 | 00 | 00 | 00 | 0C | 00 | FF | FF | | | | | | | | | | | | |
| 01 CHG | 81 | 0A | FF | FF | 00 | 00 | 00 | 00 | FF | 00 | 00 | 00 | | | | | | | | | | | | |
| 02 SAV | 82 | 0E | 80 | 80 | 00 | 0A | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | | | | | | | | |
| 02 DEF | 82 | 0E | 80 | 80 | 00 | 0A | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | | | | | | | | |
| 02 CHG | 82 | 0E | FF | FF | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 87 | 00 | 00 | 00 | | | | | | | | |
| 03 SAV | 83 | 16 | 00 | 18 | 00 | 3B | 00 | 00 | 00 | 00 | 00 | B0 | 02 | 00 | 00 | 01 | 00 | 20 | 00 | 3C | 40 | 00 | 00 | 00 |
| 03 DEF | 83 | 16 | 00 | 18 | 00 | 3B | 00 | 00 | 00 | 00 | 00 | B0 | 02 | 00 | 00 | 01 | 00 | 20 | 00 | 3C | 40 | 00 | 00 | 00 |
| 03 CHG | 83 | 16 | 00 | 00 | FF | FF | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| 04 SAV | 84 | 16 | 00 | 18 | 9C | 04 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 1C | 3C | 00 | 00 |
| 04 DEF | 84 | 16 | 00 | 18 | 9C | 04 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 1C | 3C | 00 | 00 |
| 04 CHG | 84 | 16 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| 07 SAV | 87 | 0A | 00 | 11 | 68 | 00 | 00 | 00 | 00 | 00 | FF | FF | | | | | | | | | | | | |
| 07 DEF | 87 | 0A | 00 | 11 | 68 | 00 | 00 | 00 | 00 | 00 | FF | FF | | | | | | | | | | | | |
| 07 CHG | 87 | 0A | 0F | FF | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | | | | | | | | | | | | |
| 08 SAV | 88 | 12 | 14 | 00 | FF | FF | 00 | 00 | FF | FF | FF | FF | 80 | 03 | 00 | 00 | 00 | 00 | 00 | 00 | | | | |
| 08 DEF | 88 | 12 | 14 | 00 | FF | FF | 00 | 00 | FF | FF | FF | FF | 80 | 03 | 00 | 00 | 00 | 00 | 00 | 00 | | | | |
| 08 CHG | 88 | 12 | B5 | 00 | FF | FF | FF | FF | FF | FF | 00 | 00 | A0[1] | FF | 00 | 00 | 00 | 00 | 00 | 00 | | | | |
| 0A SAV | 8A | 0A | 02 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | | | | | | | | | | | | |
| 0A DEF | 8A | 0A | 02 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | | | | | | | | | | | | |
| 0A CHG | 8A | 0A | 00 | 03 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | | | | | | | | | | | | |
| 1A SAV | 9A | 0A | 00 | 02 | 00 | 00 | 00 | 01 | 00 | 00 | 00 | 04 | | | | | | | | | | | | |
| 1A DEF | 9A | 0A | 00 | 02 | 00 | 00 | 00 | 01 | 00 | 00 | 00 | 04 | | | | | | | | | | | | |
| 1A CHG | 9A | 0A | 02 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | | | | | | | | | | | | |
| 1C SAV | 9C | 0A | 00 | 04 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 01 | | | | | | | | | | | | |
| 1C DEF | 9C | 0A | 00 | 04 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 01 | | | | | | | | | | | | |
| 1C CHG | 9C | 0A | 0C | 0F | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | | | | | | | | | | | | |
| 00 SAV | 80 | 02 | 00 | 00 | | | | | | | | | | | | | | | | | | | | |
| 00 DEF | 80 | 02 | 00 | 00 | | | | | | | | | | | | | | | | | | | | |
| 00 CHG | 80 | 02 | 77 | 00 | | | | | | | | | | | | | | | | | | | | |

[1] Though byte 12, bit 7 (A0) 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).

**Table 10: SCSI bus conditions and other miscellaneous features**

| Supported by SCSI-2/SCSI-3 | Conditions or feature |
|---|---|
| N | Adaptive Caching |
| Y | Adaptive Read Look-ahead |
| Y | Arbitrating System |
| Y | Asynchronous Data Transfer |
| N | Asynchronous Event Notification |
| Y | Attention Condition |
| Y | Capacity Programming |
| Y | Contingent Allegiance Condition |
| 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 |
| Y | Parameter Rounding |
| Y | Queue tagging (up to 64 Que tags supported) |
| Y | Reporting actual retry count in Extended Sense bytes 15, 16 and 17. |
| Y | Reset Condition |
| Y | Segmented Caching |
| N | Synchronized (locked) Spindle Operation |
| Y | Synchronous Data Transfer |
| N | Zero Latency Read |
| | |
| **Supported by SCSI-2/SCSI-3** | **Status supported** |
| Y | Busy |
| Y | Check Condition |
| N | Condition Met/Good |
| Y | Good |
| N | Intermediate/Condition Met/Good |
| Y | Intermediate/Good |
| Y | Queue Full |
| Y | Reservation Conflict |

## 9.5 Synchronous data transfer

### 9.5.1 Synchronous data transfer periods supported

Table 11 and Section 9.5.2 list Synchronous Data transfer periods supported by the drive. 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*, part number 77738479.

**Table 11: Synchronous data transfer periods for drive**

| M (decimal) | Transfer period (M times 4 nanoseconds) |
|---|---|
| 12 [1] | 50 [1] |
| 15 [1] | 62.5 [1] |
| 18 [1] | 75 [1] |
| 25 | 100 |
| 31 | 125 |
| 37 | 150 |
| 50 | 200 |
| 62 | 250 |
| 75 | 300 |
| 87 | 350 |
| 100 | 400 |

**Note.**

[1] FAST-20 SCSI transfer periods.

### 9.5.2 REQ/ACK offset

The maximum value supported by the Barracuda 4XL family drives for REQ/ACK offset is 15 (0Fh).

## 9.6 Physical interface

Figure 15 shows the locations of the drive physical interface components for the N drives. Shown are the locations of the DC power connector, the SCSI interface connector, the I/O line terminators, and the drive select and option select headers.

Details of the physical, electrical and logical characteristics are given in sections following, while the SCSI operational aspects of Seagate drive interfaces are given in the Seagate *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 Section 9.8 and Section 9.9 for additional terminator information.

### 9.6.1 DC cable and connector

“N” and “W” model drives receive DC power through a 4 pin connector (see Figures 15 and 16 for pin assignments) mounted at the rear of the main PCB. Recommended part numbers of the mating connector are listed below, but equivalent parts may be used.

| Type of cable | Connector | Contacts (20-14 AWG) |
|---|---|---|
| 14 AWG | MP 1-480424-0 | AMP 60619-4 (Loose Piece) |
| | | AMP 61117-4 (Strip) |

“WC” and “DC” model drives receive power through the 80 pin I/O connector. See Tables 16 and 17.

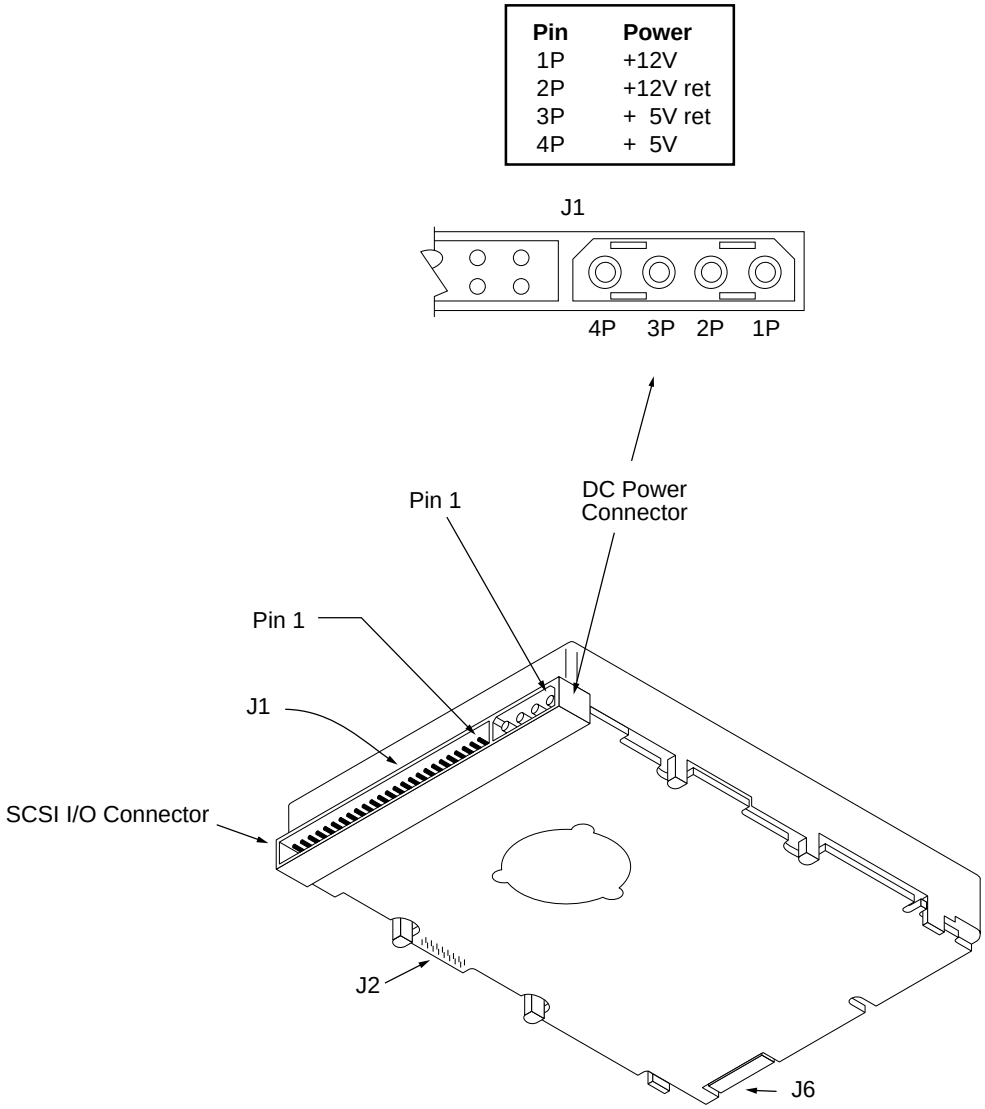



**Figure 15. Physical interface for “N” model drives**

| Pin | Power |
|---|---|
| 1P | +12V |
| 2P | +12V ret |
| 3P | + 5V ret |
| 4P | + 5V |

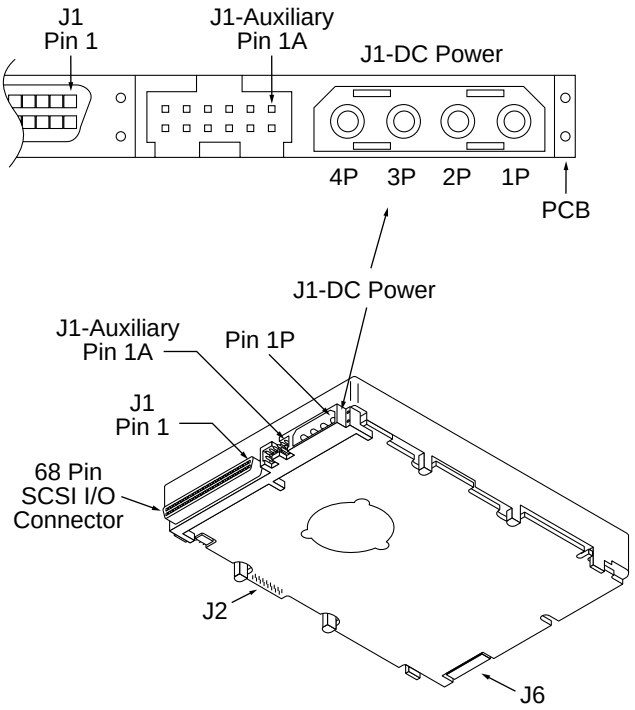
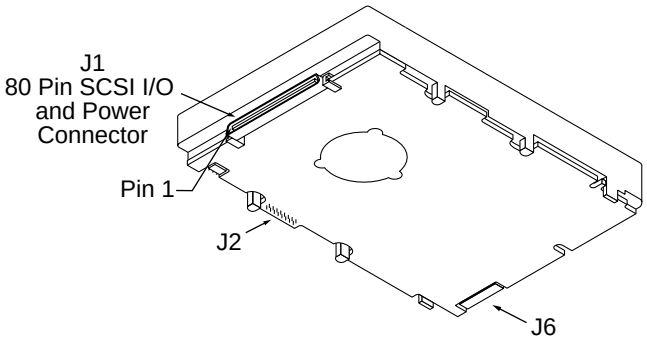



**Figure 16. Physical interface for “W” and “WD” model drives**




Note: See Tables 16 and 17 for DC power pin assignments.

**Figure 17. Physical interface for “WC” and “DC” 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,” “W,” and “WC” 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 circuit. A maximum of 8 (“N” models) or 16 (“W” and “WC”) SCSI devices (including the Host) may be daisy-chained together. The SCSI devices at both ends of the daisy chain are to be terminated. Intermediate SCSI devices shall not be terminated (see Figure 18). Remove the terminator enable jumper **TE** on J2 select header (“N” and “W” models), or the external terminators (“WD” model) not the terminator power source selector jumper **TP** (Figure 12).

“WC” and “DC” model drives plug into PCB or bulkhead connectors in the Host. They may be connected in a daisy chain by the host backplane wiring or PCB circuit runs that have adequate DC current carrying capacity to support the number of drives plugged into the PCB or bulkhead connectors. A single 80 pin I/O connector cable cannot support the DC current needs of several drives, so no daisy-chain cables beyond the bulkhead connectors should be used. A single drive connected via a cable to a host 80 pin I/O connector is not recommended.

### 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 listed in Table 12 is recommended for unshielded flat cable or twisted pair ribbon cable. 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 shielded and unshielded cables are mixed within the same SCSI bus, the effect of impedance mismatch must be carefully considered. Proper impedance matching is especially important in order to maintain adequate margin at FAST SCSI transfer rates.

Model “N” drives use nonshielded cable connectors. A 50 conductor flat cable or 25 twisted pair cable shall be used. A minimum conductor size of 28 AWG should be used to minimize noise effects.

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

Model “W” and “WD” drives use nonshielded cable connectors. A 68 conductor flat cable or 34 twisted pair cable shall be used with connectors listed in 9.6.4. A minimum conductor size of 28 AWG should be used to minimize noise effects.

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

**For “WC” and “DC” models:**

The 80 pin connector option is intended for use on drives that plug directly into a PCB or wall/bracket mounted connector in the host equipment. Installations with connectors on cables are not recommended.

#### 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 12 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 12: 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.) [1] | 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 13, 14, and 16.

#### 9.6.3.2 Differential I/O circuits (“WD” and “DC” 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 Tables 15 and 17.

### 9.6.4 Mating connectors

Part numbers for the different type connectors that mate with the various Barracuda 4XL I/O connectors are given in the following sections.

#### 9.6.4.1 Mating connectors for “N” models

The nonshielded cable connector shall be a 50 conductor connector consisting of two rows of 25 female contacts with adjacent contacts 0.1 inches (2.54 mm) apart.

Recommended mating flat cable connector part numbers are:

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

[1] See Figure 18.

The drive device connector is a nonshielded 50 conductor connector consisting of two rows of 25 male pins with adjacent pins 0.1 inches (2.54 mm) apart. The connector is keyed (see Figure 19).

Mating panel mount connector: 3M-CHE-2050-J01A10-KLE.

#### 9.6.4.2 Mating connectors for “W” and “WD” models

The nonshielded cable connector shall be a 68 conductor connector consisting of two rows of 34 male contacts with adjacent contacts 0.050 inches (1.27 mm) apart.

Recommended mating flat cable 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 | (0.050 inches (1.27mm, 50 mil) conductor centers, 28 or 30 AWG wire). Use two, 34 conductor, 0.050 inches (1.27 mm, 50 mil) 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, 0.025 68es (0.68 mm, 25 mil) 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 18.

The drive device connector is a nonshielded 68 conductor connector consisting of two rows of 34 female pins with adjacent pins 0.050 inches (1.27 mm) apart. The connector is keyed by means of its shape (see Figure 20).

#### 9.6.4.3 Mating connectors for “WC” and “DC” models

The nonshielded connector shall be an 80 conductor connector consisting of two rows of 40 contacts with adjacent contacts 0.050 inches (1.27 mm) apart. I/O connection using a cable is not recommended. The length and size of the host equipment DC power carrying conductors from the DC power source to the host equipment 80 pin disk drive interface connector(s) should be strictly designed according to proper power transmission design concepts. No possibility for the equipment user to attach an 80 pin cable/connector should be allowed, since the length of the DC power carrying conductors could not be controlled and therefore could become too long for safe power transmission to the drive. Daisy-chain 80 conductor cables should especially not be allowed, since the power-carrying conductors on the 80 conductor interface were not intended to support a series of drives.

Small Form Factor Specification SSF-8046, Rev. 2.7 details mating requirements.

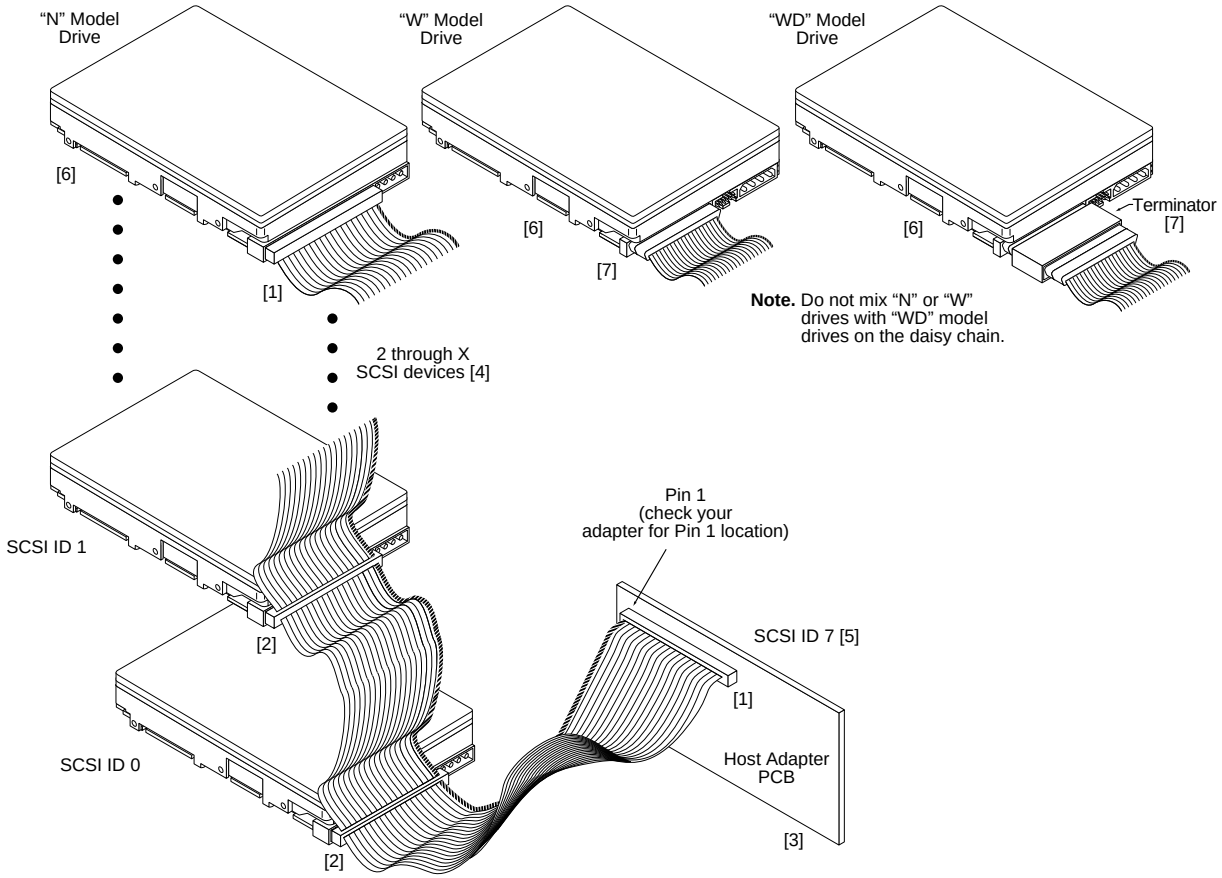
Recommended mating 80-position PCB mount connectors:

| **Straight-in connector** | | **Hot Plug version (with ground guide-pin)** |
|---|---|---|
| Seagate P/N: | 77678703 | |
| Amp US P/N: | 2-557103-1 | 787311-1 with polarization |
| or | 94-0680-02-1 | |
| Amp US P/N: | 2-557103-2 | 787311-2 without polarization |
| or | 94-0680-02-2 | |
| Amp Japan P/N: | 5-175475-9 | |

**Right-angle to PCB connectors**

Seagate P/N: 77678559 Amp US P/N: 2-557101-1 Amp Japan P/N: 5-175474-9

For additional information call Amp. FAX service at 1-800-522-6752.




[1] Closed end type 50 pin connector used. Install terminator enable (**TE**) jumper.

[2] Open end type (in-line application) connector used. Remove terminator enable (**TE**) jumper.

[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.

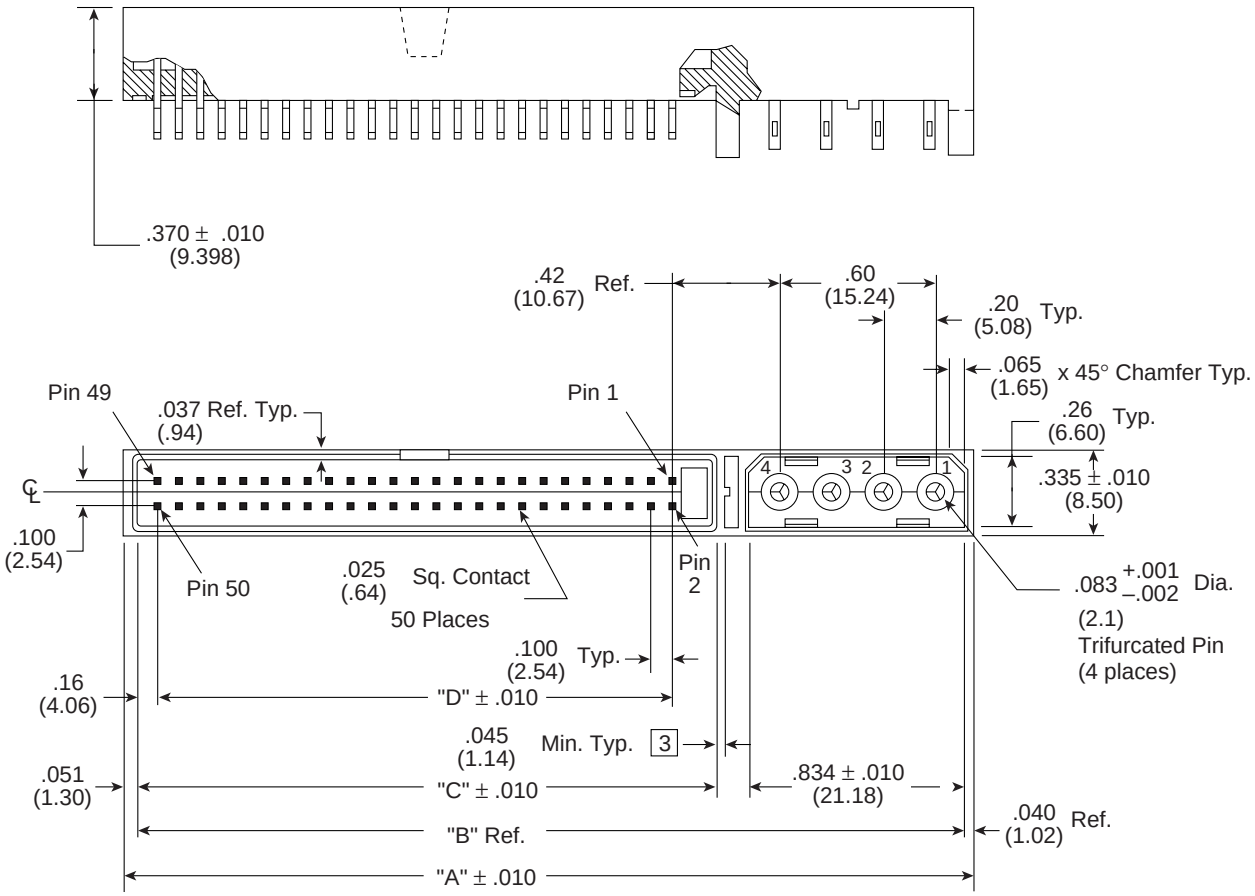
[4] Total interface cable length must not exceed that specified in Section 9.6.3.1 (including host adapter/initiator). The cable length restriction limits the total number of devices allowed. See Table 12.

[5] SCSI ID7 has highest arbitration priority, ID0 has lowest for "N" models. For "W" models, priority is ID7 to ID0, then ID15 to ID8 (ID 8 very lowest).

[6] Last drive on the daisy chain.

[7] Open-end type 68-pin connector used. Terminators disabled on "WD" models. If end "WD" device, external terminator and closed-end type 68-pin connector used. On "W" models, install terminator enable **(TE)** jumper plug. "N" and "W" drives do not require external terminators.

**Figure 18. SCSI daisy-chain interface cabling for "N," "W," and "WD" model drives**




| No. Pos. | "A" | "B" | "C" | "D" |
|---|---|---|---|---|
| 50 | 3.767 (95.68) | 3.697 (93.90) | 2.720 (69.09) | 2.400 (60.96) |

**Figure 19. Nonshielded 50 pin SCSI device connector used on “N” model drives**

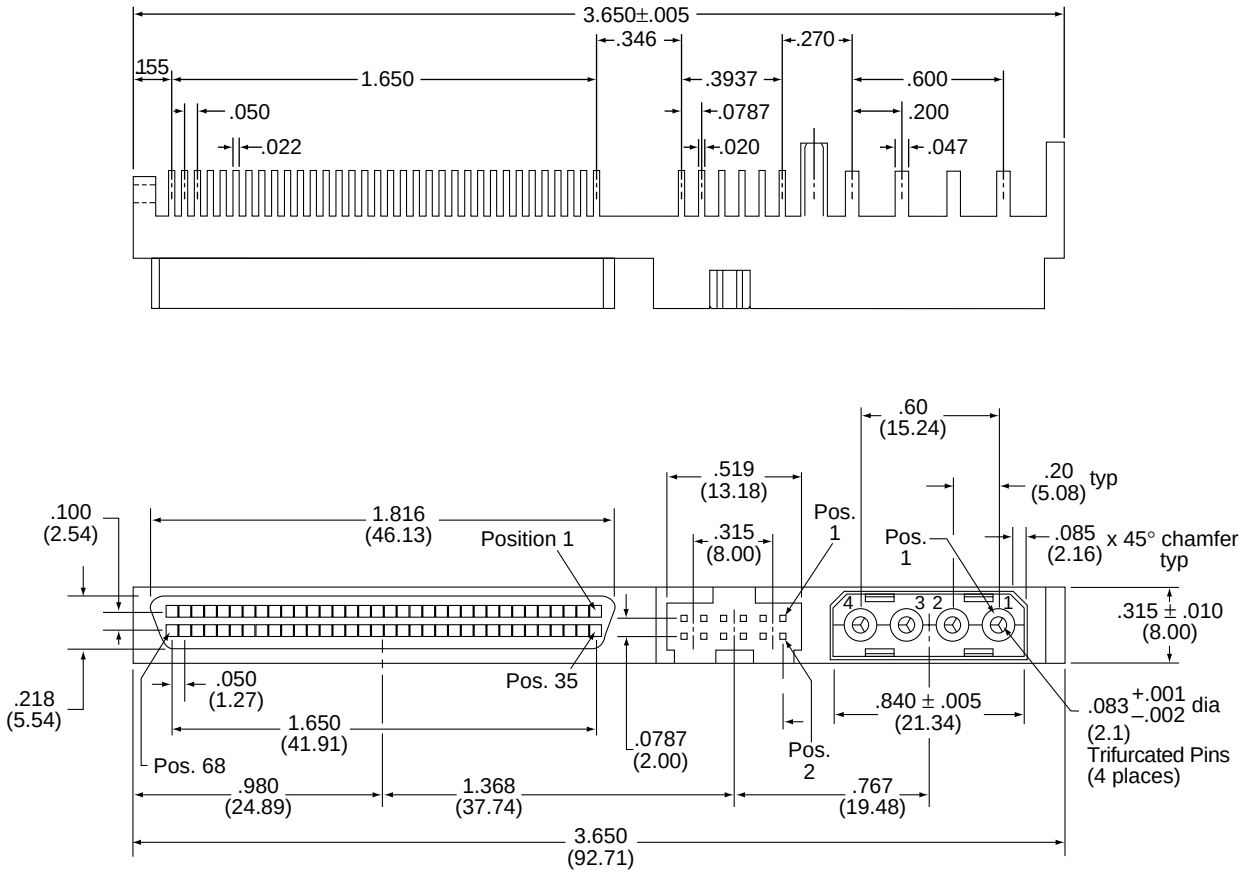



**Figure 20. Non-shielded 68 pin SCSI device connector used on “W” and “WD” model drives**

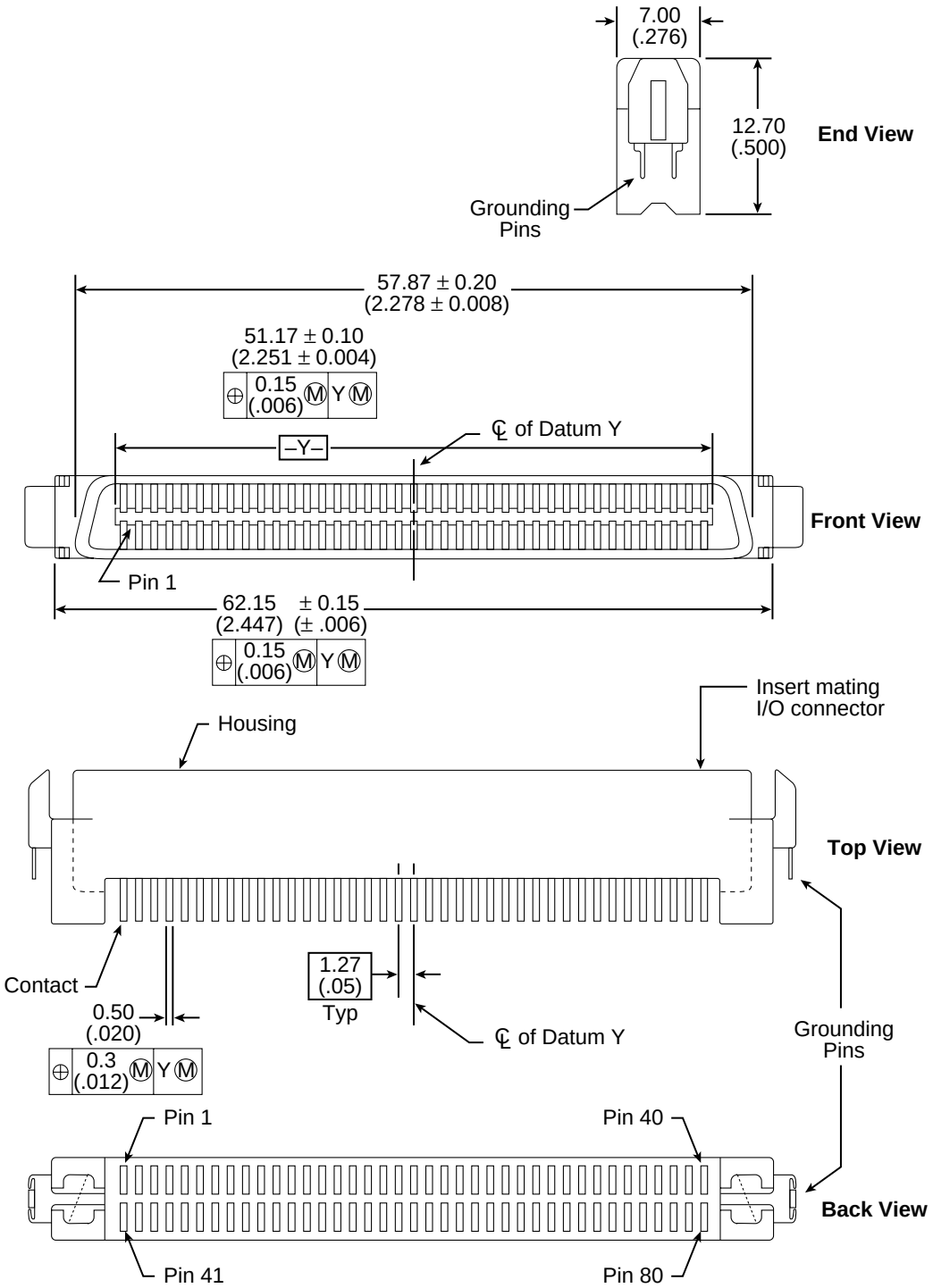



**Figure 21. Non-shielded 80 pin SCSI “SCA-2” connector, used on “WC” and “DC” model drives**

**Table 13: Model "N," single ended I/O, 50 conductor, signal/contact assignments**

**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 [11] | | Connector contact number [11] | 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 [10] | 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 of the cable. If the I/O cable should accidently be plugged in upside down, terminator power on pin 26 will be shorted to ground.

**Note.** See page following Table 17.

**Table 14: "W" models single ended I/O cable 68 conductor signal/contact assignments**

**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] |
|---|---|---|---|---|---|
| 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 |

**Note.** See page following Table 17.

**Table 15: "WD" models differential cable 68 conductor signal/pin assignments (Nonshielded connector)[13]**

**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 |

See page following Table 17.

**Table 16: "WC" models single ended I/O, 80 conductor cable signal/contact assignments**

**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] | Signal number [3] | Contact name[1] |
|---|---|---|---|
| 12 V CHARGE | 1 | 41 | 12 V GND |
| 12 V | 2 | 42 | 12 V GND |
| 12 V | 3 | 43 | 12 V GND |
| 12 V | 4 | 44 | MATED 1 |
| NC [10] | 5 | 45 | NC [10] |
| NC [10] | 6 | 46 | GND [8] |
| –DB11 | 7 | 47 | GND |
| –DB10 | 8 | 48 | GND |
| –DB9 | 9 | 49 | GND |
| –DB8 | 10 | 50 | GND |
| –I/O | 11 | 51 | GND |
| –REQ | 12 | 52 | GND |
| –C/D | 13 | 53 | GND |
| –SEL | 14 | 54 | GND |
| –MSG | 15 | 55 | GND |
| –RST | 16 | 56 | GND |
| –ACK | 17 | 57 | GND |
| –BSY | 18 | 58 | GND |
| –ATN | 19 | 59 | GND |
| –DBP | 20 | 60 | GND |
| –DB7 | 21 | 61 | GND |
| –DB6 | 22 | 62 | GND |
| –DB5 | 23 | 63 | GND |
| –DB4 | 24 | 64 | GND |
| –DB3 | 25 | 65 | GND |
| –DB2 | 26 | 66 | GND |
| –DB1 | 27 | 67 | GND |
| –DB0 | 28 | 68 | GND |
| –DP1 | 29 | 69 | GND |
| –DB15 | 30 | 70 | GND |
| –DB14 | 31 | 71 | GND |
| –DB13 | 32 | 72 | GND |
| –DB12 | 33 | 73 | GND |
| +5 V | 34 | 74 | MATED 2 |
| +5 V | 35 | 75 | 5 V GND |
| +5 V CHARGE | 36 | 76 | 5 V GND |
| NC [10] | 37 | 77 | ACTIVE LED OUT [4] [9] |
| RMT-START [5] [9] | 38 | 78 | DLYD-START [6] [9] |
| SCSI ID (0) [7] [9] | 39 | 79 | SCSI ID (1) [7] [9] |
| SCSI ID (2) [7] [9] | 40 | 80 | SCSI ID (3) [7] [9] |

**Note.** See page following Table 17.

**Table 17: "DC" differential models, 80 pin I/O connector pin assignments (Non-shielded connector) [13]**

**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] | Signal number [3] | Contact name[1] |
|---|---|---|---|
| 12 V CHARGE | 1 | 41 | 12 V GND |
| 12 V | 2 | 42 | 12 V GND |
| 12 V | 3 | 43 | 12 V GND |
| 12 V | 4 | 44 | MATED 1 |
| NC [10] | 5 | 45 | NC [10] |
| NC [10] | 6 | 46 | DIFFSENS [8] |
| –DB11 | 7 | 47 | +DB11 |
| –DB10 | 8 | 48 | +DB10 |
| –DB9 | 9 | 49 | +DB9 |
| –DB8 | 10 | 50 | +DB8 |
| –I/O | 11 | 51 | +I/O |
| –REQ | 12 | 52 | +REQ |
| –C/D | 13 | 53 | +C/D |
| –SEL | 14 | 54 | +SEL |
| –MSG | 15 | 55 | +MSG |
| –RST | 16 | 56 | +RST |
| –ACK | 17 | 57 | +ACK |
| –BSY | 18 | 58 | +BSY |
| –ATN | 19 | 59 | +ATN |
| –DBP | 20 | 60 | +DBP |
| –DB7 | 21 | 61 | +DB7 |
| –DB6 | 22 | 62 | +DB6 |
| –DB5 | 23 | 63 | +DB5 |
| –DB4 | 24 | 64 | +DB4 |
| –DB3 | 25 | 65 | +DB3 |
| –DB2 | 26 | 66 | +DB2 |
| –DB1 | 27 | 67 | +DB1 |
| –DB0 | 28 | 68 | +DB0 |
| –DP1 | 29 | 69 | +DP1 |
| –DB15 | 30 | 70 | +DB15 |
| –DB14 | 31 | 71 | +DB14 |
| –DB13 | 32 | 72 | +DB13 |
| –DB12 | 33 | 73 | +DB12 |
| +5 V | 34 | 74 | MATED 2 |
| +5 V | 35 | 75 | 5 V GND |
| +5 V CHARGE | 36 | 76 | 5 V GND |
| NC [10] | 37 | 77 | ACTIVE LED OUT [4] [9] |
| RMT-START [5] [9] | 38 | 78 | DLYD-START [6] [9] |
| SCSI ID (0) [7] [9] | 39 | 79 | SCSI ID (1) [7] [9] |
| SCSI ID (2) [7] [9] | 40 | 80 | SCSI ID (3) [7] [9] |

**Note.** See page following this table.

**Notes [ ] for Tables 13 through 17.**

[1] See Section 9.7.1 or 9.6.4.2 for detailed electrical characteristics of these signals.

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

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

[4] Front panel LED signal; indicates drive activity for host front panel hard drive activity indicator.

[5] Asserted by host to enable Motor Start option (enables starting motor via SCSI bus command).

[6] Asserted by host to enable Delayed Motor Start option (motor starts at power on or after a delay of 12 seconds times drive ID). This and [3] above are mutually exclusive options.

[7] Binary code on A3, A2, A1 and A0 asserted by host to set up SCSI bus ID in drive.

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

[9] Signals [4] through [7] are used in place of installing jumpers and cables on option select connectors J2 and J6. See Section 8.1.1 notes.

[10] “NC” means no connection.

[11] The conductor number refers to the conductor position (right to left in Figure 18) when using 0.050 inches (1.27 mm) centerline flat ribbon cable. Other cable types may be used to implement equivalent contact assignments.

[12] Connector contacts are on 0.100 inches (2.54 mm) centers.

[13] 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.
All other signals shall be connected as defined.

## 9.7 Electrical description

"N" and "W" 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.

"WD" models use differential interface signals and each of these must be terminated at each end of the total cable with 330 ohms to +5V 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.

"WC" and "DC" models use the single connection attachment (SCA) connector. This 80-pin connector is designed to plug directly into a back panel or plane. No external cables are required. Active terminators on the back panel must be provided by the user. This connector is not recommended where cabling is required.

### 9.7.1 Single-ended drivers/receivers

For "N," "W," and "WC" models which use single-ended drivers and receivers, typical circuits are shown in Figure 22. Terminator circuits (Note [1]) are to be enabled only when the disc drive is first or last in the daisy chain.

#### 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.

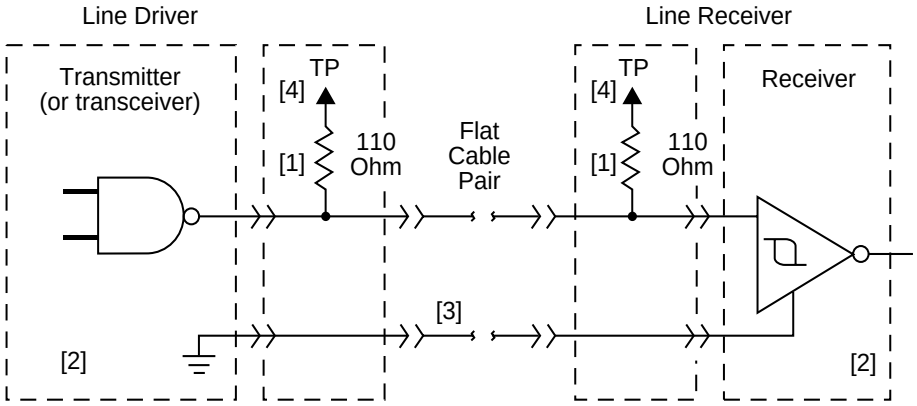



**Figure 22. Single-ended transmitters and receivers**

**Notes.**

[1] Part of active terminator circuits. Non-removable LSI terminators, enabled in the drive (models "N" and "W" only) with jumper plug **TE** when it is first or last in the daisy chain. Interface signals levels and logical sense at the drive I/O connector are defined as follows:

| Logic level | Driver output | Receiver input |
|---|---|---|
| NEGATED (0) | ≥2.5 V: <5.25 V | ≥2.0 V: ≤5.25 V |
| ASSERTED (1) | ≤0.4 V: >0.0 V | ≤0.8 V: ≥0. 0 V |

The difference in the voltages between input and output signals is due to the losses in the cable.

[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 Figure 12. Applies to "N" and "W" models.

### 9.7.2 Differential drivers/receivers

Differential drivers and receivers are used by the “WD,” and “DC” models. Typical circuits are shown in Figure 23. 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. Drive user or systems integrator must provide some external means of termination.

#### Output characteristics

Each signal driven by differential interface drives shall have the following output characteristics when measured at the disc drive 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.

*These voltages shall be measured between the output terminal and the SCSI device’s logic ground reference.

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

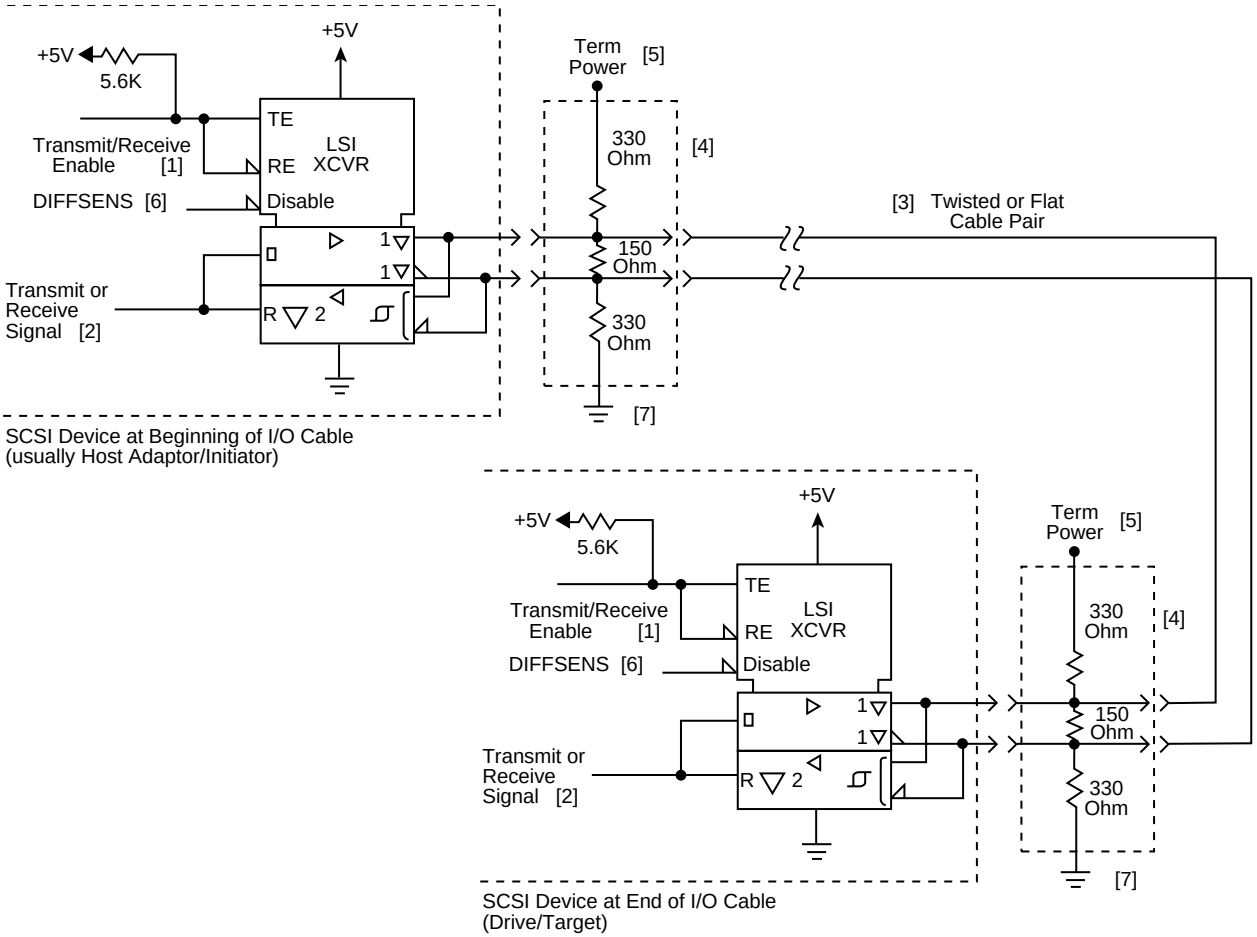
#### Input characteristics

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

Input current on either input = +2.0 milliamps maximum (includes both receivers and passive drivers).

This requirement shall be 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 shall additionally conform to EIA RS-485-1983.




**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** (Figure 7d) is installed in rightmost position “**TP**.” See pin assignment Tables 14 and 15 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 Tables 14 and Table 17.

**Figure 23. Typical differential I/O line transmitter/receiver and external terminators**

## 9.8 Terminator requirements

Internal disc drive I/O termination (provided only in model “N” and “W” drives single ended I/O model drives) consists of active circuits in an LSI module that is permanently mounted on the PCB. All single initiator/single target (non-daisy-chain) applications require that the Initiator and disc drive be terminated. Daisy-chain applications require that only the units at each end of the daisy chain be terminated. All other peripherals on the chain must not be terminated. (See Figure 18).

**Note.** Remove drive terminator enabling jumper **TE** where terminators are not required. Removal of terminator power source selection jumper **TP** (see Figure 12) does not disconnect the terminator resistors from the circuit.

It is highly recommended that ANSI SCSI-2 Standard’s Alternative 2 termination (active termination) be used for applications with single-ended (“N” and “W” models), especially if the bus will be operated at transfer rates above 5 Mbytes/sec. The “N” and “W” models provide on-board active termination that can be disabled by removal of the enable jumper **TE** (see Figure 12).

**Note.** ACTIVE TERMINATORS ARE HIGHLY RECOMMENDED FOR USE IN THE DAISY CHAIN AS DESCRIBED ABOVE. ACTIVE AND PASSIVE TERMINATORS SHOULD NOT BE MIXED ON THE SAME SCSI BUS.

Drive models “WD,” “WC,” and “DC” do not have internal terminators available. The user, systems integrator or host equipment manufacturer must provide a terminator arrangement external to the drive. For “WD” models, terminator modules can be purchased that plug between the SCSI I/O cable and the drive I/O connector or on the end of a short I/O cable stub extending past the last cable connector.

## 9.9 Terminator power

### “N” and “W” model 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:
   “N” models Pin 26
   “W” models Pins 17, 18, 51, and 52
2. Drive supplies power to the SCSI bus.
3. Drive provides terminator power for optional internal terminator resistors using the drive’s power connector.
4. 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:

8-bit SCSI V TERM = 4.25 V to 5.25 V
800 mA minimum source drive capability
1.0 A maximum

16-bit SCSI V TERM = 4.25 V to 5.25 V
1,500 mA minimum source drive capability
3.0 A maximum

### “WD” model 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.

### “WC” and “DC” model drives

These drives cannot furnish terminator power because no conductors in the 80-pin I/O connector are devoted to terminator power.

## 9.10 Disc drive SCSI timing

**Table 18: Disc drive SCSI timing**

| Description | Waveform symbol [1] | Waveform table [1] | Typical timing |
|---|---|---|---|
| Target Select Time (no Arbitration) [4] | T00 | N/A | <2 µs |
| Target Select Time (with Arbitration) [4] | T01 | 4.5-1,2 | <2 µs |
| Target Select to Command | T02 | 4.5-1 | 3.77 µs |
| Target Select to MSG Out | T03 | 4.5-2 | 1.57 µs |
| Identify MSG to Command | T04 | 4.5-3 | 3.36 µs |
| Command to Status | T05 | 4.5-5 | Command Dependent |
| Command to Data (para. In) | T06 | 4.5-9 | Command Dependent |
| Command to Data (para. Out) | T07 | 4.5-10 | Command Dependent |
| Command to Data (Write to Data Buffer) | T08 | 4.5-10 | Command Dependent |
| Command to Disconnect MSG | T09 | 4.5-6 | Command Dependent |
| Disconnect MSG to Bus Free | T10 | 4.5-6,14 | 0.52 µs |
| Disconnect to Arbitration (for Reselect)<br>This measures disconnected CMD overhead | T11 | 4.5-6 | Command Dependent |
| Target win Arbitration (for Reselect) | T12 | 4.5-7 | 3.00 µs |
| Arbitration to Reselect | T13 | 4.5-7 | 1.60 µs |
| Reselect to Identify MSG In | T14 | 4.5-7 | 1.39 µs |
| Reselect Identify MSG to Status | T15 | 4.5-8 | Command Dependent |
| Reselect Identify MSG to Data (media) | T16 | 4.5-11 | Command Dependent |
| Data to Status | T17 | 4.5-15 | Command Dependent |
| Status to Command Complete MSG | T18 | 4.5-5,8,15 | 0.98 µs |
| Command Complete MSG to Bus Free | T19 | 4.5-5,8,15 | 0.51 µs |
| Data to Save Data Pointer MSG | T20 | 4.5-14 | 4.00 µs |
| Save Data Pointer MSG to Disconnect MSG | T21 | 4.5-14 | 0.79 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 | 0.58 µs |
| Next CDB Byte Access (Byte 3 of 6) | T23.6.3 | 4.5-4 | 0.12 µs |
| Next CDB Byte Access (Byte 4 of 6) | T23.6.4 | 4.5-4 | 0.12 µs |
| Next CDB Byte Access (Byte 5 of 6) | T23.6.5 | 4.5-4 | 0.12 µs |
| Next CDB Byte Access (Byte 6 of 6) | T23.6.6 | 4.5-4 | 0.12 µs |
| Next CDB Byte Access (Byte 2 of 10) | T23.10.2 | 4.5-4 | 0.59 µs |
| Next CDB Byte Access (Byte 3 of 10) | T23.10.3 | 4.5-4 | 0.11 µs ±1 µs |
| Next CDB Byte Access (Byte 4 of 10) | T23.10.4 | 4.5-4 | 0.12 µs ±1 µs |
| Next CDB Byte Access (Byte 5 of 10) | T23.10.5 | 4.5-4 | 0.11 µs ±1 µs |
| Next CDB Byte Access (Byte 6 of 10) | T23.10.6 | 4.5-4 | 0.11 µs ±1 µs |
| Next CDB Byte Access (Byte 7 of 10) | T23.10.7 | 4.5-4 | 0.13 µs ±1 µs |
| Next CDB Byte Access (Byte 8 of 10) | T23.10.8 | 4.5-4 | 0.12 µs ±1 µs |
| Next CDB Byte Access (Byte 9 of 10) | T23.10.9 | 4.5-4 | 0.12 µs ±1 µs |
| Next CDB Byte Access (Byte 10 of 10) | T23.10.10 | 4.5-4 | 0.12 µs ±1 µs |

**Table 18: Disc drive SCSI timing (Continued)**

| Description | Waveform symbol [1] | Waveform table [1] | Typical timing |
|---|---|---|---|
| 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 | 0.12 µs |
| Next Data Out Byte Access (parameter) | T27 | 4.5-13 | 0.12 µs |
| Data In Byte Transfer (media) [2] | T28 | 4.5-12 | 0.04 µs |
| Data Out Byte Transfer (media) [2] | T29 | 4.5-13 | 0.04 µs |
| Next Data In Byte access (media [2] | T30 | 4.5-12 | 0.12 µs |
| Next Data Out Byte access (media [2] | T31 | 4.5-13 | 0.12 µs |
| MSG IN Byte Transfer | T32 | 4.5-5,7,8,14,15 | 0.04 µs |
| MSG OUT Byte Transfer | T33 | 4.5-2 | 0.04 µs |
| STATUS Byte Transfer | T34 | 4.5-5,8,15 | 0.04 µs |
| Synchronous Data Transfer Characteristics: | | | |
| Request Signal Transfer Period [3] | – | – | various |

**Notes.**

[1] See *SCSI Interface Product Manual* (part number 77738479), Section 4.5

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

[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* for a description of synchronous data transfer operation.

General timing diagrams for SCSI interface operation are shown in the *SCSI Interface Product Manual*, Section 4.5. The specific timing values that apply to this drive are listed in Table 18.

## 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 |
| Taiwan | 886-2-719-6075 |
| Thailand | 662-531-8111 |
| USA | Disc: 405-936-1600; Tape: 405-936-1630 |

### 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 | Disc: 405-936-1620; Tape: 405-936-1640 |

***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 |
| Germany | 49-89-1430-5100 |

| Location | Phone number |
|---|---|
| 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 | Disc: 405-936-1685; Tape: 405-936-1683 |

## 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<br>(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.<br>(8:00 A.M. to 1:15 P.M., 2:30 P.M. to 7:00 P.M., Central time, M–F) |

***SeaTDD™ 405-936-1687***

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 8:00 A.M. to 1:15 P.M. and 2:30 P.M. to 7:00 P.M. (Central time) Monday through Friday.

## Customer service centers

Seagate direct OEM, Distribution, and Systems 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 | 65-488-7503 |
| 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<br>1-800-624-9857 | 905-812-7807 |
| Mexico | | |
| Abicom Seamax SA DE CV | 525-546-6965 | 525-546-4888 |

# Index

## Symbols



## Numerics



## A



## B



## C

## D



## E

## F



## G



## H



## I



## J



## L



## M

## N



## O



## P

## R



## S

## T



## U



## V



## W



## Z

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