Seagate

Barracuda 2, 2HP Disc Drive

ST12450W/WD

Product Manual, Volume 1

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Publication number: 83328900, Rev. B
October 1995

Revision status summary sheet

Revision	Date	Writer/Engineer	Sheets Affected
A (preliminary-01)	1/25/94	L. Newman/J. Olson	All
A (preliminary-02)	2/15/94	L. Newman/J. Olson	All
A	3/29/94	L. Newman/J. Olson	All
B	10/3/95	L. Newman/J. Olson	8, 14, 15, 19, 24, 25, 26, 27, 29, 30, 32, 43, 44, 49, 51, 52, 53, 55, 60

Note. Product Manual 83328900 is Volume 1 of a two-volume document with the SCSI interface information in the *Volume 2 SCSI-2 Interface Product Manual,* Part Number 77738479.

Contents

Figures

1.0 Scope

This manual describes Seagate Technology®, Inc. Barracuda™ 2, 2HP (2 head parallel) disc drives.

Barracuda drives support the Small Computer System Interface-2 (SCSI-2) as described in the ANSI SCSI and SCSI-2 interface specifications to the extent described in this manual. This manual defines the performance characteristics of the Barracuda 2, 2HP drives. The *SCSI-2 Interface Product Manual* (part number 77738479) describes general SCSI interface characteristics of this and other families of Seagate drives.

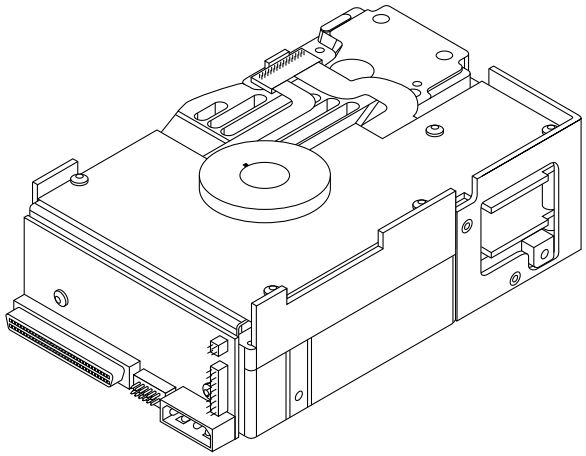


Figure 1. Barracuda 2, 2HP disc drive

2.0 Applicable standard and reference documentation

Seagate takes all reasonable steps to insure that its products are certifiable to currently accepted standards. Typical applications of these disc drives include customer packaging and subsystem design.

Safety agencies conditionally certify component parts, such as the Barracuda disc drive, based on their final acceptability in the end-use product. The subsystem designer is responsible for meeting these conditions of acceptability in obtaining safety/regulatory agency compliance in their end-use product and certifying where required by law.

2.1 Standards

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

The Barracuda disc drive is supplied as a component part. It is the responsibility of the subsystem designer to meet EMC/regulatory requirements. Engineering test characterizations of radiated emissions are available from the Seagate safety department.

2.2 Applicable reference documents

Barracuda 2, 2HP Installation Guide
Seagate part number: 83328890

SCSI-2 Interface Product Manual (volume 2)
Seagate part number: 77738479

ANSI small computer system interface (SCSI) documents

ANSI X3.131-1986	(SCSI-1)
X3T9.2/86-109 Rev. 10H	(SCSI-2)
X3T9.2/91-010 Rev. 10	(SCSI-3) Parallel Interface

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

3.0 General description

Barracuda drives are low-cost, high-performance, random-access storage devices designed to meet the needs of the original equipment manufacturer (OEM) marketplace.

The Barracuda 2, 2HP drive has two read/write channels on the circuit board. The SCSI-2 controller chip is modified to process data for two read/write channels at once. This technology effectively doubles the internal data transfer rate when compared to a conventional Barracuda 2 disc drive.

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

The head and disc assembly (HDA) is environmentally 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.

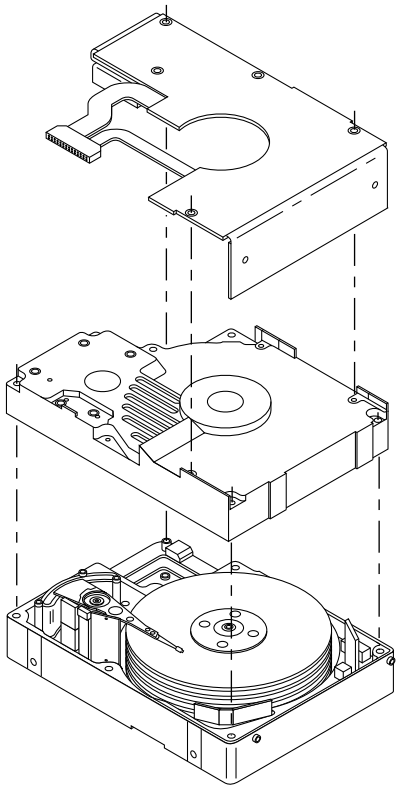


Figure 2. Barracuda 2, 2HP disc drive (exploded view)

Barracuda 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 the 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 disengages when power is applied to the drive and the head load process begins.

Barracuda drives decode track 0 location data from the dedicated servo 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.

4.0 Standard features

Barracuda 2, 2HP drives have the following standard features:

- 2 head parallel technology
- Integrated SCSI controller
- Single-ended or differential SCSI drivers and receivers
- Asynchronous and synchronous data-transfer protocols
- Firmware downloadable using a SCSI interface
- Selectable sector size from 180 to 4,096 bytes per sector
- Programmable sector-reallocation scheme
- Flawed sector reallocation at format time
- Programmable auto-write and auto-read reallocation
- Reallocation of defects on command (post format)
- 96-bit Reed-Solomon error-correction code
- Sealed head and disc assembly (HDA)
- No preventive maintenance or adjustments required
- Dedicated head-landing zone
- Automatic shipping lock
- Automatic thermal compensation
- Embedded Grey Code track address to eliminate seek errors
- Self-diagnostics performed at power-on
- 1:1 interleave
- Zone bit recording (ZBR)
- Vertical, horizontal, or top-down mounting
- Dynamic spindle brake
- Permanently mounted IC terminators (ST12450W models only)
- 1,024 Kbyte data buffer (see Section 5.5)

4.1 Performance

- Simultaneously processes data for two read/write channels (heads)
- Programmable multi-segmentable cache buffer
- 7,200 RPM spindle; average latency = 4.17 msec
- Command queuing of up to 64 commands
- Background processing of queue
- Supports start and stop commands
- Provides synchronized spindle capability
- Low audible noise for office environment
- Low power consumption

4.1.1 Reliability

- 500,000 hour MTBF
- Adaptive seek velocity; improved seek performance
- LSI circuitry
- Balanced low-mass rotary voice-coil actuator

4.2 Unformatted and Formatted Capacities

Standard OEM models are formatted to have 512-byte sectors.

ST12450 drives have nine (9) spare sectors per cylinder and one (1) spare cylinder per unit.

Formatted	Unformatted
1,849 Mbytes	2,437 Mbytes

Users having the necessary equipment may modify the data block size before issuing a format command to obtain different formatted capacities. User-available capacity also depends on the spare reallocation scheme selected. See the Mode Select command and the Format command in the *SCSI-2 Interface Product Manual* (part number 77738479).

4.3 Options

The capacity shown in Section 4.2 is normally provided. Other capacities can be ordered depending on the sparing scheme and sector size requested.

The following options are incorporated at the time of production or are available separately.

- Front panel (green lens), part number 70869751

  The standard front panel is black plastic. You may order other colors. Each panel has a single rectangular green LED indicator lens that, when glowing, indicates the drive is selected.

- *Barracuda 2, 2HP Installation Guide,* part number 83328890

  This manual provides basic information on the care and handling of Winchester disc peripherals in general. Some drive installation information is included to assist those persons not familiar with the product. It also includes basic information to assist in obtaining service for the drive.

- Single-unit shipping pack kit

  The drive is shipped in bulk packaging to provide maximum protection against transit damage. Units shipped individually require additional protection as provided by the single-unit shipping pack.

- Adapter accessory frame kit, part number 75790701

  This kit contains the frame to allow a 3.5-inch drive to be mounted in a 5.25-inch drive bay. It includes mounting hardware, front panel with a green lens, an LED with cable that connects to the remote LED connector, and installation instructions.

4.4 Installation

For option jumper locations and definitions refer to Figure 14. Drive default mode parameters are not normally needed for installation. Refer to Section 11.3.2 for default mode parameters if you need them.

- Ensure that the SCSI ID of the drive is not the same as the host adapter.
- If multiple devices are on the bus, set the drive's 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. Internal termination is available on single-ended (ST12450W) drives by enabling this feature with a jumper (see Figure 14). External terminators are required for differential (ST12450WD) drives. These external terminators must be provided by the user, systems integrator, or host equipment manufacturer.
- If you attach the drive to a bus that contains other devices, and the new drive is not attached to the end of the bus, remove termination from the new drive.
- Set all appropriate option jumpers prior to applying power to the drive. If you change jumpers after applying power, recycle the drive's power to make the new settings effective.

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. You select a different sector size.
  b. You select a different spare-sector allocation scheme.

5.0 Performance characteristics

This section provides performance-related characteristics and features of Barracuda 2, 2HP drives.

5.1 Internal drive characteristics

Drive capacity, Mbytes unformatted	2,437
Read/write data heads, maximum (physical)	18
Read/write data heads, maximum (logical)	9
Bytes per track, average bytes	99,536
Bytes per surface, Mbytes unformatted	271.4
Cylinders/tracks per surface, user accessible	2,710
Tracks per inch	3,047
Bits per inch	52,187
Servo heads	1
Internal data rate per physical head, Mbits/sec, variable with zone	34.3 to 56.5
Internal data rate per logical head, Mbits/sec, variable with zone	68.6 to 113.0
Disc rotation speed	7,200 ± 0.5%
Average rotational latency, msec	4.17

5.2 SCSI seek performance characteristics

All performance characteristics assume that automatic adaptive thermal compensation is not in process when the drive receives the SCSI command. Automatic adaptive thermal compensation will not interrupt an active SCSI command. If adaptive thermal compensation is in process when a SCSI command is received, the command is queued until the compensation for the specific head being compensated completes. When compensation completes for the specific head being compensated, the first queued SCSI command executes. When execution of the first queued command is complete, the drive continues the compensation for the remaining head(s).

The above procedure continues until compensation for all heads has completed, or until 10 minutes have elapsed. The drive initiates an automatic adaptive thermal compensation cycle once on power-up before completing its initialization sequence and then once after 1 minute from the end of initialization. After this, the drive initiates an automatic adaptive thermal compensation cycle approximately once every 10 minutes. Non-interruptible automatic thermal compensation occurs at other times but should be transparent to the user (e.g., during format, Re-zero command, at spindle-up, during read-error recovery, and during reassign-block functions). You can use the Re-zero command to reset the thermal compensation timer back to its start so that the host knows when the interruption for thermal compensation will occur.

Refer to Section 11.8 and to the *SCSI-2 Interface Product Manual* (part number 77738479) for additional timing details.

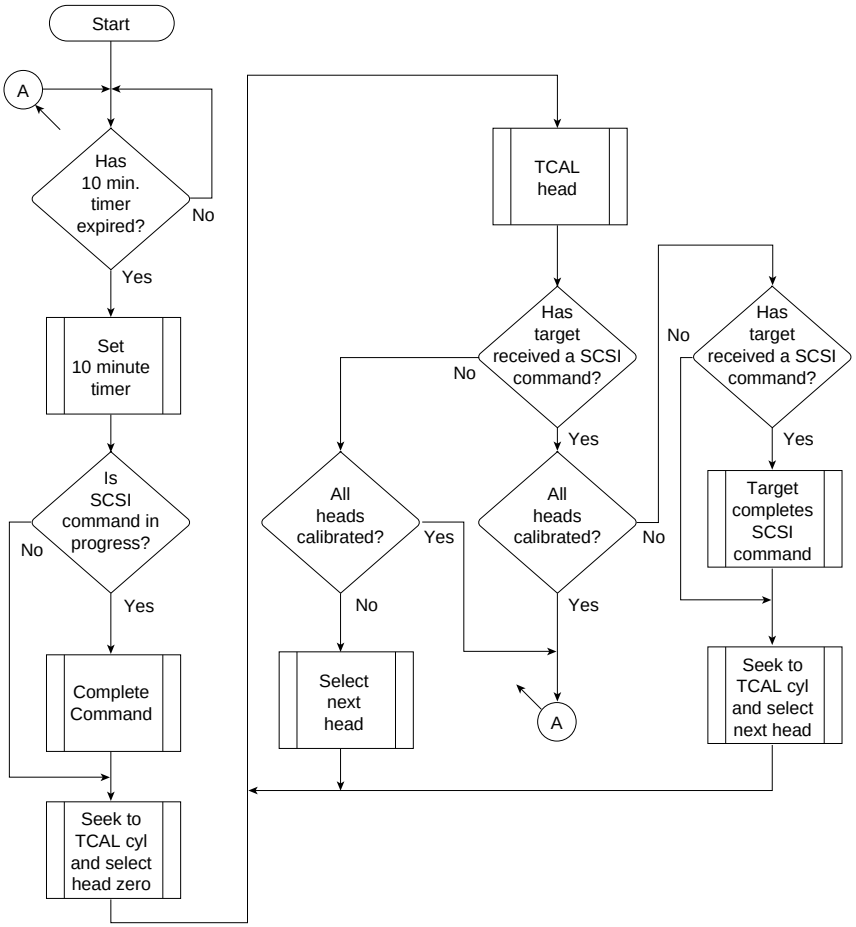


Figure 3. OEM interruptible thermal calibration implementation

5.2.1 Seek time

	Drive level Barracuda msec		Drive including controller overhead without disconnect	
	read	**write**	**read**	**write**
Average typical*	8.0	9.0	9.0	10.0
Single track typical*	0.6	0.9	1.6	1.9
Full stroke typical*	17	19	18.0	20.0

*Typical seek values are measured under nominal conditions of temperature, voltage, and horizontal orientation on a representative sample of drives.

5.2.2 Format drive command execution time for ≥ 512-byte sectors

Maximum (with verify)	18 minutes
Maximum (without verify)	12 minutes

5.3 General performance characteristics

Minimum sector interleave	1 to 1
Data buffer to/from disc media (512-byte sector)	
Data transfer rate (≤ 1 sector)	
Minimum	8.56 Mbytes/sec*
Maximum	14.11 Mbytes/sec*
Data transfer rate (< 1 track)	
Minimum	6.2 Mbytes/sec*
Maximum	10.3 Mbytes/sec*
SCSI interface data	
Asynchronous transfer rate	Asynchronous*
Maximum instantaneous	10.0 Mbytes/sec**
Sector sizes	
Default	512-byte data blocks
Variable in even-sector sizes	180 to 4,096 bytes
Synchronous transfer rate, 2 bytes wide	5.0 to 20 Mbytes/sec
Read/write consecutive sectors on a track	Yes
Flaw reallocation performance impact (for flaws reallocated using the spare sectors per track reallocation scheme)	Negligible
Flaw reallocation performance impact (for flaws reallocated using the spare sectors per cylinder reallocation scheme)	Negligible
Flaw reallocation performance impact (for flaws reallocated using the spare tracks per volume reallocation scheme)	35 msec (typical)
Overhead time for head switch	0.7 msec
Overhead time for one-track cylinder switch	1.6 msec (typical)
Average rotational latency	4.17 msec

* Rate measured from the start of the first sector transfer to or from the host.

** Assumes system ability to support 5.0 Mbytes/sec, 2 bytes wide, and no cable loss.

5.4 Start/stop time

Disabling the Motor Start option causes the drive to become ready within 30 seconds after DC power is applied at nominal voltage. This means the motor starts as soon as power is applied. If a recoverable error condition is detected during the start sequence, the drive will execute a recovery procedure and may cause the time to become ready to exceed 30 seconds. During this time the drive responds to some commands over the SCSI interface. Stop time is less than 30 seconds (maximum) from removal of DC power.

Enabling the Motor Start option causes the internal controller to accept the commands listed in the *SCSI-2 Interface Product Manual* (77738479) less than 3 seconds after applying DC power. After receiving the Motor Start command, the drive becomes ready for normal operations within 30 seconds (excluding error recovery procedure). The Motor Start command can also be used to command the drive to stop the spindle (see the Start/Stop command information in the *SCSI-2 Interface Product Manual).*

There is no power control switch on the drive.

5.5 Prefetch/multi-segmented cache control

The drive provides a prefetch/multi-segmented cache algorithm, which in many cases enhances system performance. To select this feature, the host sends the Mode Select command with the proper values in the applicable bytes in page 08h (see the *SCSI-2 Interface Product Manual).* Default is prefetch and cache operation enabled.

Of the 1,024 Kbytes physical buffer space, approximately 960 Kbytes can be used as a cache. The cache can be divided into logical segments from which data is read and to which data is written.

The drive keeps track of the logical block addresses of the data stored in each segment of the cache. If the cache is enabled (see RCD bit, Table 5.2.1-27 in the *SCSI-2 Interface Product Manual),* data requested by the host with a read command is retrieved from the cache before any disc access is initiated. Data in contiguous logical blocks immediately beyond that requested by the Read command can be retrieved and stored in the cache for immediate transfer to the initiator on subsequent read commands. This is referred to as the prefetch operation. Since data that is prefetched may replace data already in the cache segment, an initiator can limit the amount of prefetch data to optimize system performance. The drive never prefetches more sectors than the number specified in bytes 8 and 9 of Mode page 08h (see the *SCSI-2 Interface Product Manual).* If the cache is not enabled, 960 Kbytes of the buffer are used as a circular buffer for read/writes, with no prefetch operation and no segmented cache operation.

The following is a simplified description of the prefetch/cache operation:

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

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

2. When a requested logical block is reached that is not in any segment, the drive fetches it and any remaining requested logical block addresses from the disc and puts them in a segment of the cache. The drive transfers the remaining requested logical blocks from the cache to the initiator in accordance with the "buffer-full" ratio specification given in Mode Select Disconnect/Reconnect parameters, page 02h (see the *SCSI-2 Interface Product Manual*).
3. The drive prefetches additional logical blocks contiguous to those transferred in step 2 above and stores them in the segment. The drive stops filling the segment when the maximum prefetch value has been transferred (see the *SCSI-2 Interface Product Manual*).

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

1. The drive fetches the requested logical blocks from the disc and transfers them into a segment, then from there to the initiator in accordance with the "buffer-full" ratio specification given in Mode Select Disconnect/Reconnect parameters, page 02h (see the *SCSI-2 Interface Product Manual*).
2. The drive prefetches additional logical blocks contiguous to those transferred in Case A, step 2 above and stores them in the segment. The drive stops filling the segment when the maximum prefetch value has been transferred.

During a prefetch, the drive crosses a cylinder boundary to fetch data only if the Discontinuity (DISC) bit is set to 1 in bit 4 of byte 2 of the Mode Select parameters page 8h. Default is zero for bit 4 (see the *SCSI-2 Interface Product Manual*).

Each cache segment is actually a self-contained circular buffer whose length is an integer number of sectors. The wrap-around capability of the individual segments greatly enhances the cache's overall performance, allowing a wide range of user-selectable configurations including a pure prefetch strategy. The drive supports operation of any integer number of segments from 1 to 16. Divide the 976,896 bytes in the buffer by the number of segments to get the segment size. Default is 3 segments. (See the *SCSI-2 Interface Product Manual*.)

5.5.1 Adaptive read lookahead

Read lookahead causes the drive to continue reading data from the disc following a normal read I/O until the read-ahead parameters are satisfied (prefetch). If subsequent I/O requests can be satisfied from the prefetched data in the data buffer, there is a significant improvement in performance since a disc access is eliminated. If subsequent I/O requests cannot be satisfied from the prefetched data, there is a reduction in performance due to prefetch overhead.

The adaptive read lookahead feature suspends the prefetch operation if three subsequent read I/O requests are not satisfied from the prefetched data. This improves performance because unnecessary prefetches are avoided.

Prefetch is reinstated if an I/O request is sequential to a previous I/O request.

5.6 Caching write data

Write caching is a drive-write operation, which uses a drive's buffer storage area where data to be written to the disc is stored while the drive performs the Write command.

Write caching is enabled along with read caching. Default is cache enabled. For write caching, the same buffer space and segmentation is used as set up for read functions. When a write command is issued, the cache is first checked to see if any logical blocks 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 a 10-byte CDB write command (2Ah) is issued with the data page out (DPO) bit set to 1, no write data is cached, but the cache segments are still checked and cleared, if needed, for any logical blocks that are being written (see the *SCSI-2 Interface Product Manual).*

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, data is written into the beginning of the same cache segment, overwriting data that was written there at the beginning of the operation. However, the drive does not overwrite data that has not yet been written to the disc.

5.7 Synchronized spindle operation

The synchronized spindle operation allows several drives operating from the same host to operate their spindles at the same synchronized rotational rate. Drives operating in a system in synchronized mode increase the system's capacity and transfer rate in a cost-effective manner.

The interface consists of a twisted-pair cable, which connects the drives in the synchronized system in a daisy-chain configuration as shown in Figure 4.

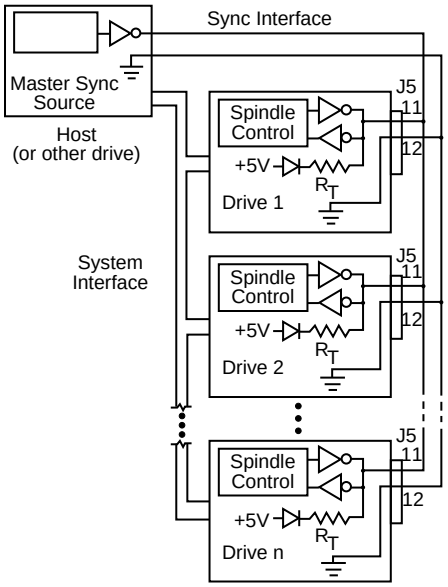


Figure 4. Synchronized drive interconnect diagram

The host can reconfigure the drive any time after power-up to be the master or a slave by using the Mode Select command on the Rigid Disc Drive Geometry page. The master provides the reference signal to which all other drives phase-lock, including the master. There is only one master per system, and that can be a drive or the host computer. All drives may be configured as slaves allowing the host to provide the reference signal.

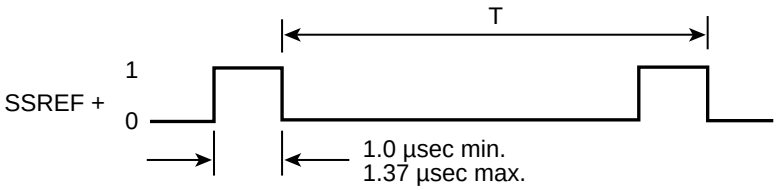
Each drive also can be configured for the non-synchronized mode in which it ignores any reference signal that might be present—this is the default mode as shipped from the factory. Connect the synchronized reference signal to the host only if the host provides the reference signal. If the host does not provide the reference signal, do not connect the host.

Rotational position locking

Note. Mode Select page 4, byte 17, bits 1 and 0.

RPL	Description
00b	Spindle synchronization is disabled (default value)
01b	The target operates as a synchronized-spindle slave
10b	The target operates as a synchronized-spindle master
11b	The target operates as a synchronized-spindle master control (not supported by the disc drive)

The VIC 2 LSI on the master drive provides the reference signal (SSREF+). The index signal generates a 120 Hz signal. The signal is normally false/negated (nominal 0V) and makes a transition to the true/asserted (nominal +5V) level to indicate the reference position during the revolution period. Master and slave drives use the trailing (falling) edge of the reference signal to phase lock their spindles. A maximum of 10 seconds is allowed for a slave to synchronize with the reference signal. Figure 5 shows the characteristics of the reference signal.



T = 0.0083 seconds (± 1.0% max)
± 10 microseconds cycle-to-cycle variance
± 20 microseconds phase error while synchronized

Figure 5. Synchronized reference signal characteristics

SCSI interface factors

The Rotational Position Locking (RPL) field in byte 17 (bits 0 and 1) of the Rigid Disc Drive Geometry mode parameters page (page 04h) is used for enabling and disabling spindle synchronization mode (see the *SCSI-2 Interface Product Manual*). When the target reaches synchronization, it creates a unit attention to all initiators. The sense key is set to Unit Attention and the additional sense code is set to Spindles Synchronized (5C01).

After reaching synchronization, if the target detects a change of synchronization and:

1. If the logical unit is not executing an I/O process for the initiator, then the target creates a unit attention condition. The sense key is set to Unit Attention and the additional sense code is set to Spindle Synchronized (5C01) or Spindle Not Synchronized (5C02).
2. If the logical unit is executing an I/O process and no other error occurs, then the target returns Check Condition status. The sense key is set to Recovered Error if the target is able to complete the I/O process or to Hardware Error if the target is unable to complete the I/O process. The additional sense code is set to Spindle Synchronized (5C01) or Spindle Not Synchronized (5C02).

You may operate the drive with a rotational skew when synchronized. The rotational skew is applied in the retarded direction (lagging the synchronized-spindle master control). A rotational offset of up to 255/256 of a revolution lagging may be selected. Select the amount of offset by using the Mode Select command, Rigid Disc Drive Geometry page (page 04), byte 18 (see the *SCSI-2 Interface Product Manual).* The value in byte 18 (0–FFh) is the numerator of a fractional multiplier that has 256 as the denominator. For example, 40h selects 40h/FFh or 1/4 of a revolution lagging skew, 80h selects 1/2 of a revolution lagging skew, etc. Since the drive supports all offset values from 0 to 255, values sent by the initiator are not rounded off. The drive's translation of the digital offset values to physical rotational offsets results in offset values whose phase error lies within the ± 20 microseconds phase error with respect to the supplied 120 Hz reference signal.

The drive does not have the capability to adjust the rotational offset value requested by the initiator to a physical offset in the drive that corresponds in any way to sector boundaries or changes in ZBR zones. The initiator must formulate these boundaries or changes, if required, to calculate the value of offset it sends to the drive.

6.0 Reliability specifications

The following reliability specifications assume correct host and drive interface, including all interface timings, power supply voltages, and environmental requirements.

Seek error rate	Less than 10 errors in 10^8 seeks
Recoverable error rate	Less than 10 errors in 10^{11} bits transferred (using default settings)
Unrecovered data	Less than 1 sector in 10^{14} bits transferred
Miscorrected data	Less than 1 sector in 10^{21} bits transferred
MTBF	500,000 hours
Service life	5 years
Preventive maintenance	None required

6.1 Error rates

The error rates stated in this manual assume the following:

- The drive is operated per this manual using DC power as defined in Section 7.2.
- The drive has been formatted with the SCSI format commands.
- Errors caused by media defects or host system failures are excluded from error rate computations. Refer to Section 9.0.

6.1.1 Environmental interference

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

An unrecoverable error or condition is defined as one that:

- is not detected and corrected by the drive itself;
- is not capable of being detected from the error or fault status provided through the drive or SCSI interface; or
- is not capable of being recovered by normal drive or system recovery procedures without operator intervention.

6.1.2 Write errors

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

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

6.1.3 Seek errors

A seek error is defined as a failure of the drive to position the heads at the addressed track. There must be no more than one recoverable seek error in 10^7 physical seek operations. After detecting an initial seek error, the drive automatically reseeks to the addressed track up to three times. If a reseek is successful, the extended sense report indicates 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 (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-2 Interface Product Manual* (part number 77738479).

6.2 Reliability and service

You can enhance the reliability of Barracuda 2, 2HP disc drives by ensuring that the drive receives adequate cooling. This section provides recommended air-flow information, temperature measurements, and other information that may be used to enhance the service life of the drive.

6.2.1 Mean time between failures (MTBF)

The production disc drive achieves an MTBF of 500,000 hours when operated in an average local disc drive ambient temperature of 95°F (35°C) or less. Short-term excursions up to the specification limits (122°F, 50°C) of the operating environment will not affect MTBF performance.

The following expression defines MTBF:

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

Estimated power-on operating hours means the estimated total power-on hours for all drives in service.

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

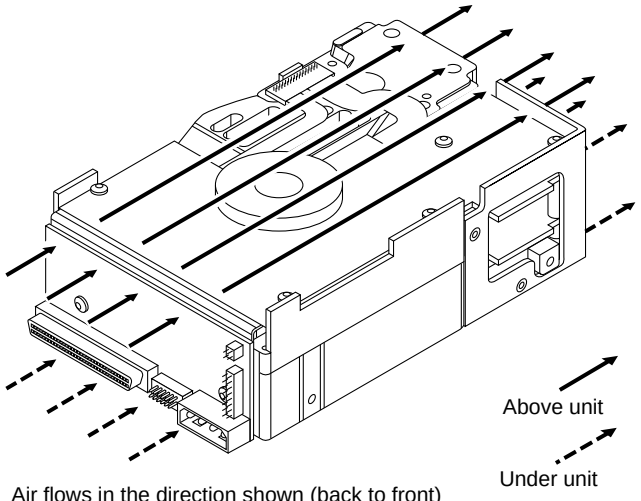
Data is calculated on a rolling-average base for a minimum period of six months.

6.2.2 Air flow

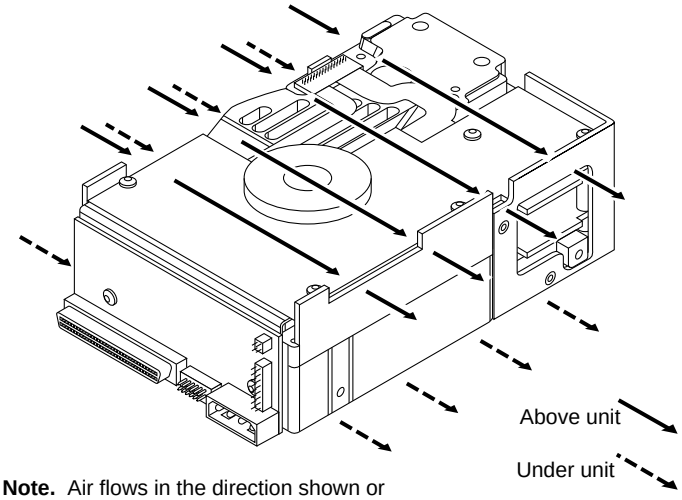
The rack, cabinet, or drawer environment for the Barracuda 2, 2HP drive must provide cooling of the electronics and head and disc assembly (HDA). You should confirm that adequate cooling is provided using the temperature measurement guidelines described below.

Orient the drive or direct air flow so that the least amount of air-flow resistance is created while providing air flow to the electronics and HDA. Also, choose the shortest possible path between the air inlet and exit to minimize the travel length of air heated by the Barracuda 2, 2HP drive and other heat sources within the rack, cabinet, or drawer environment.

Possible air-flow patterns are shown in Figure 6. Create the air-flow patterns by using one or more fans, either forcing or drawing air as shown in the illustrations. Other air-flow patterns are acceptable as long as the temperature measurement guidelines are met.



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



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

Figure 6. Air flow (ST12450W shown)

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

Maximum allowable operating temperatures are listed in the last column. Operation above these values may adversely affect the drive's ability to meet functional specifications.

Air-flow cooling
ST12450W
single-ended

Card	Component	Reference	MTBF 500k hours case temperature (°C)
GYHX	Transmitter	1	64
GYHX	Detector	2	73
GYHX	VIC 2	3	59
GYHX	Flash PROM	4	59
HDA housing		Figure 9	

The air-flow pattern with which the temperature guidelines above were generated is shown in Figure 6. Local average air velocities were 0.61 msec (120 lfpm) and inlet air temperature to the drive was 30°C (86°F).

The maximum allowable HDA case temperature is 60°C.

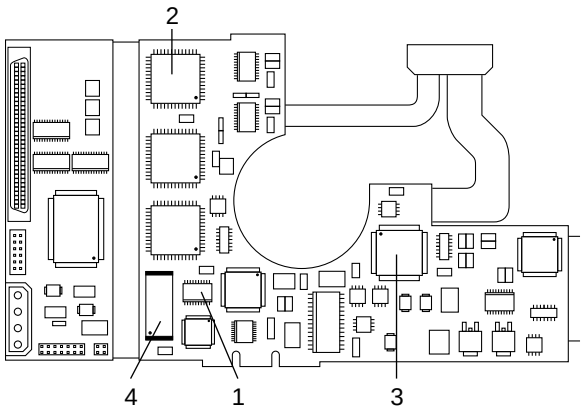


Figure 7. GYHX temperature measurement locations

Air-flow cooling
ST12450WD
differential

Card	Component	Reference	MTBF 500k hours case temperature (°C)
RYGX	Transmitter	1	64
RYGX	Detector	2	73
RYGX	VIC 2	3	59
RYGX	Flash PROM	4	59
HDA housing		Figure 9	

The air-flow pattern with which the temperature guidelines above were generated is shown in Figure 6. Local average air velocities were 0.61 msec (120 lfpm) and inlet air temperature to the drive was 30°C (86°F).

The maximum allowable HDA case temperature is 60°C.

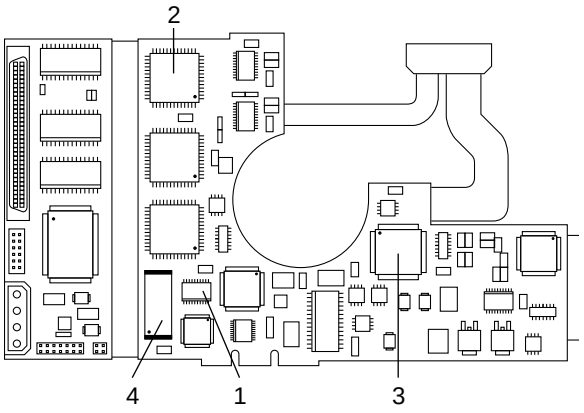


Figure 8. RYGX temperature measurement locations

Measure the HDA housing temperature at the location specified in Figure 9.

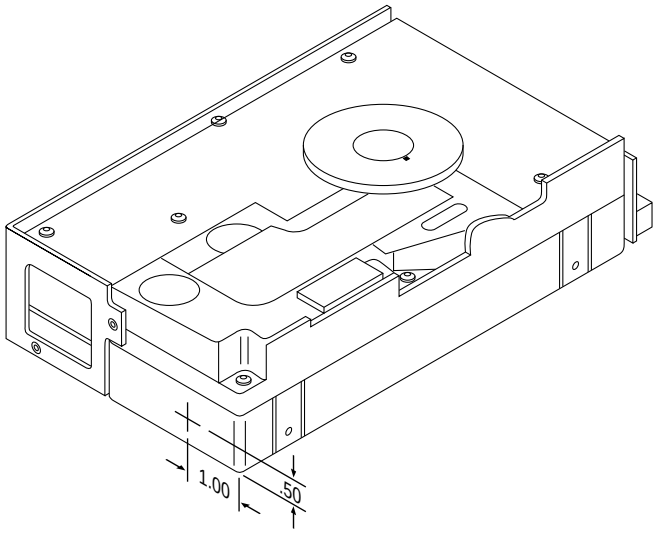


Figure 9. Temperature measurement location

6.2.3 Preventive maintenance

No preventive maintenance is required.

6.2.4 Service life

The drive has a useful service life of five years. Depot repair or replacement of major parts is permitted during this period.

6.2.5 Service philosophy

Special equipment is required to repair the drive's HDA. To achieve the 5-year 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. The drive's warranty is voided if the HDA is opened.

6.2.6 Installation

The drive is designed, manufactured, and tested with a "plug in and play" installation philosophy. This philosophy minimizes the requirements for highly trained personnel to integrate the drive into the OEM's system, whether in a factory or field environment. Refer to the *Barracuda 2, 2HP Installation Guide* (83328890) for installation instructions.

The drive has been low-level formatted at the factory and does not need to be reformatted.

6.2.7 Service tools

No special tools are required for site installation or recommended for site maintenance. Refer to Section 6.2.3. The depot repair philosophy of the drive precludes the necessity for special tools. Field repair of the drive is not practical because users cannot purchase individual parts for the drive.

6.2.8 Hot plugging Barracuda 2, 2HP 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 2, 2HP drives conform to the SCSI-3 standard requirements for glitch-free power-on and power-off. The drive maintains the high-impedance state of 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 J1.

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.

7.0 Physical/electrical specifications

This section provides information relating to the physical and electrical characteristics of Barracuda 2, 2HP drives.

7.1 AC power requirements

None.

7.2 DC power requirements

The voltage and current requirements for a single drive are shown below. Values indicated apply at the drive's power connector.

Table 1. DC power requirements

		ST12450W		ST12450WD	
Voltage regulation [5]	**Notes**	**5V[8] ±5%**	**12V ±5% [2]**	**5V[8] ±5%**	**12V ±5% [2]**
Max operating current DC 3σ	[1]	1.32a	0.91a	1.65A	0.91A
Max start current					
(peak) DC 3σ	[3] [6]	1.3A	2.18A	1.43A	2.18A
(peak) AC 3σ	[3]	—	3.1A	—	3.1A
Delay motor start (max) DC 3σ	[1] [4]	1.25A	1.5A	1.31A	1.5A
Peak operating current					
Typical DC $\overline{X}$	[1] [7]	1.3A	0.84A	1.6A	0.84A
Maximum DC 3σ	[1]	1.32A	0.91A	1.65A	0.91A
Maximum (peak) AC 3σ		1.4A	1.85A	2.4A	1.85A
Track following at					
OD DC $\overline{X}$	[1]	1.3A	0.78A	1.4A	1.85A
ID DC $\overline{X}$	[1]	1.3A	0.82A	1.4A	0.78A
Read track					
OD DC 3σ	[1] [11]	1.4A	0.81A	1.9A	0.81A
AC 3σ		1.5A	1.16A	2.5A	1.16A
Seeking					
Typical DC $\overline{X}$	[1] [10]	1.3A	1.06A	1.4A	1.06A
Maximum DC 3σ	[1]	1.3A	1.14A	1.44A	1.14A
Maximum (peak) AC 3σ		1.3A	1.85A	2.2A	1.85A

Notes:

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

[2] A –10% tolerance is permissible during initial start of the spindle and must return to ±5% before 7,200 RPM is reached. The ±5% must be maintained after the drive signals that its power-up sequence has been completed and that it can accept selection by the host initiator.

[3] See Figure 10.

[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 7.2.1 "Conducted noise immunity." Specified voltage tolerance includes ripple, noise, and transient response.

continued

continued from previous page

[6] At power-up, the motor current regulator limits the 12V current to an average value of less than 2.0A, although instantaneous peaks may exceed this value. These peaks should measure 5 msec duration or less.

[7] Operating condition is defined as a third-stroke seek at OD and read one track. A command is issued every 0.07 sec. (differential); 0.075 sec. (single-ended).

[8] No terminator power. See Section 11.7.3.4.

[9] All power-saving features enabled.

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

[11] Read track is defined as repeat reads of track 15 with a 60% duty cycle.

Notes:

1. Minimum current loading for each supply voltage is not less than 3% of the maximum operating current shown.
2. The +5V and +12V supplies 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.

7.2.1 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's power connector.

	0 to 100 kHZ	**100 kHz to 10 MHz**
+5V	150 mV	100 mV
+12V	150 mV	100 mV

7.2.2 Power sequencing

The drive does not require power sequencing. The drive protects against inadvertent writing during power-up and down. Daisy-chain operation requires that power be maintained on the terminated device to ensure proper termination of the peripheral I/O cables.

To automatically delay motor start based on the target ID (SCSI ID), select the Delay Motor Start option and deselect the Enable Motor Start option on the J4 connector. See Section 10.1 for pin selection information.

To delay the motor until the drive receives a Start Unit command, select the Enable Motor Start option on the J4 connector.

7.2.3 12V current profile

Figure 10 identifies the drive's +12V current profile. The current during the various times is as shown.

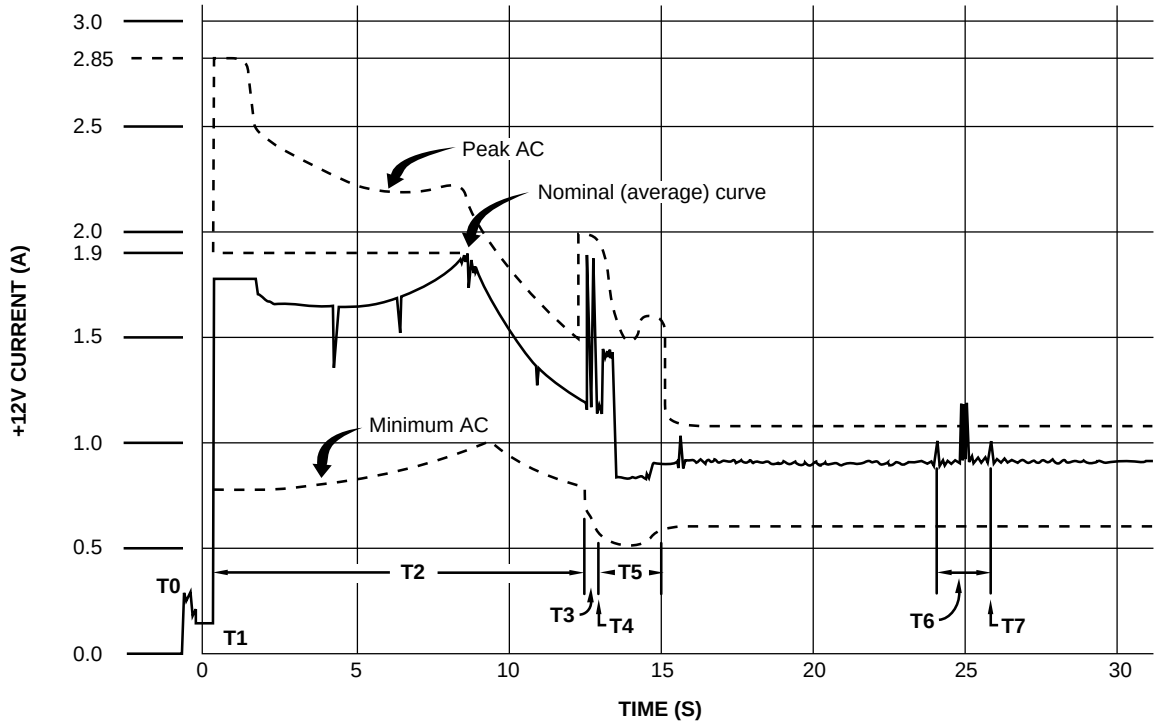


Figure 10. Typical Barracuda 2, 2HP drive +12V current profile

T0 Power is applied to the drive.

T1 Controller self-tests are performed.

T2 The spindle begins to accelerate under current limiting after performing internal diagnostics. See Note 1 of Table 1.

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

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

T5 The adaptive calibration sequence is performed.

T6 Thermal calibration.

T7 Calibration is complete and the drive is ready for reading and writing.

Note. All times and currents are typical. See Table 1 for maximum current requirements.

7.3 Heat/power dissipation

The heat and power dissipation values for your drive are listed below.

	ST12450W	ST12450WD
Typical seek and read power dissipation of DC power average at nominal voltages	16W (54 BTUs/hr)	18W (62 BTUs/hr)
Typical power dissipation under track following conditions	15W (51 BTUs/hr)	16W (54 BTUs/hr)

7.4 Environmental limits

Temperature and humidity must not cause condensation within the drive. 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).

7.4.1 Temperature

a. Operating

The MTBF specification for the drive is based on operating at a local ambient temperature of 95°F (35°C). Occasional excursions to drive ambient temperatures of 122°F (50°C) may occur without impact to specified MTBF. The enclosure for the drive should be designed such that the temperatures at the locations specified in Figures 7 and 8 are not exceeded. Air flow may be needed to achieve these temperatures. Continual or sustained operation at case temperatures above these values may degrade MTBF.

The drive meets all specifications within a 41° to 122°F (5° to 50°C) drive ambient temperature range with a maximum gradient of 36°F (20°C) per hour.

b. Non-operating

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

7.4.2 Relative humidity

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

a. Operating

5% to 95% relative humidity with a maximum gradient of 10% per hour

b. Non-operating

5% to 95% relative humidity

7.4.3 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)

7.4.4 Shock and vibration

Shock and vibration limits are measured directly on the drive's chassis. Ensure that you use an enclosure that buffers and restricts the drive's movements to meet the shock and vibration requirements listed below.

The limits of shock and vibration defined within this manual are specified with the drive mounted in one of the two methods shown in Figure 12.

7.4.4.1 Shock

a. Operating in a normal environment

The drive as installed for normal operation operates error free while subjected to intermittent shock not exceeding:

2.0 Gs at a maximum duration of 11 msec (half-sinewave)

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

b. Operating in an abnormal environment

The drive as installed for normal operation does not incur physical damage while subjected to intermittent shock not exceeding:

10 Gs at a maximum duration of 11 msec (half-sinewave)

Shock occurring at abnormal levels may degrade operating performance during the abnormal shock period. Specified operating performance continues 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 apply to all conditions of handling and transportation. This includes both isolated drives and integrated drives.

The drive does not cause drive damage or performance degradation while subjected to non-repetitive shock not exceeding:

50 Gs at a maximum duration of 11 msec (half-sinewave)

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

d. Packaged

The drive as packaged by Seagate for general freight shipment withstands a drop test against a concrete floor or equivalent with specifications not exceeding:

20 pounds (8.95 kg) for pack's gross weight

42 inches (1,070 mm) for distance dropped

Drop test applies to a single or multiple drive pack.

7.4.4.2 Vibration

a. Operating in a normal environment

The drive as installed for normal operation operates error free while subjected to continuous vibration not exceeding:

5-400 Hz @ 0.5 G

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

b. Operating in an abnormal environment

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

15 minutes of duration at major resonant frequency

5-400 Hz @ 0.75 G

Vibration occurring at these levels may degrade operating performance during the abnormal vibration period. Specified operating performance continues when normal operating vibration levels are resumed—this assumes system recovery routines are available.

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

c. Non-operating

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

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

5-22 Hz @ 0.040 inches (1.02 mm) displacement

22-400 Hz @ 2.00 Gs

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

7.4.5 Air cleanliness

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

7.4.6 Acoustics

Sound power during idle mode (when the drive is not seeking, reading, or writing) is 4.7 bels typical when measured to ISO 7779 specifications.

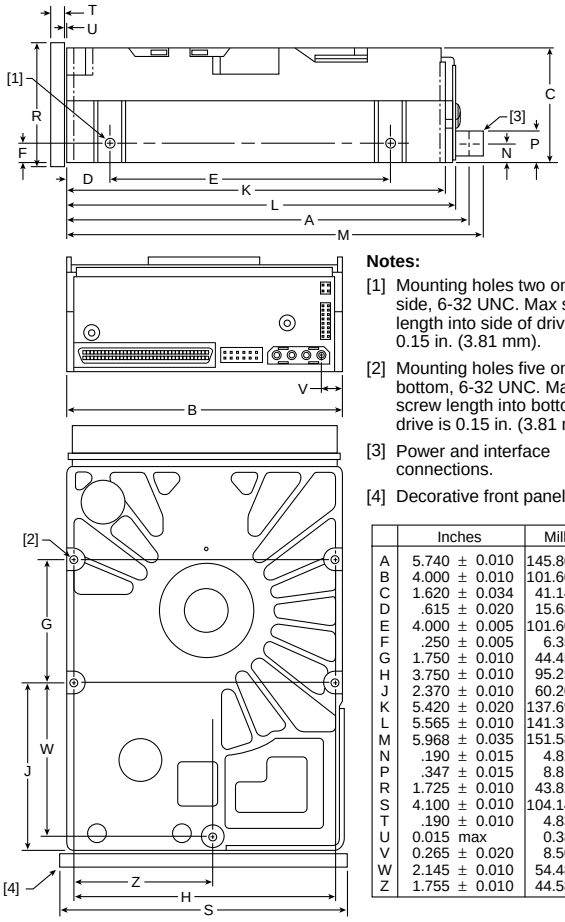
7.5 Electromagnetic compatibility

As a component assembly, the drive is not required to meet any susceptibility performance requirements. The system integrator is responsible for performing tests to ensure that equipment operating in the same system as the drive does not adversely affect the performance of the drive. See Table 1 and Section 7.2 “DC power requirements.”

7.6 Mechanical specifications

The following nominal dimensions do not include the decorative front-panel accessory. Refer to Figure 11 for detailed mounting configuration dimensions.

Height	1.63 in	41.4 mm
Width	4.00 in	101.6 mm
Depth	5.97 in	151.6 mm
Weight	2.3 lb	1.04 kg



Notes:

[1] Mounting holes two on each side, 6-32 UNC. Max screw length into side of drive is 0.15 in. (3.81 mm).

[2] Mounting holes five on bottom, 6-32 UNC. Max screw length into bottom of drive is 0.15 in. (3.81 mm).

[3] Power and interface connections.

[4] Decorative front panel.

	Inches	Millimeters
A	5.740 ± 0.010	145.80 ± .25
B	4.000 ± 0.010	101.60 ± .25
C	1.620 ± 0.034	41.14 ± .86
D	.615 ± 0.020	15.68 ± .50
E	4.000 ± 0.005	101.60 ± .13
F	.250 ± 0.005	6.35 ± .13
G	1.750 ± 0.010	44.45 ± .25
H	3.750 ± 0.010	95.25 ± .25
J	2.370 ± 0.010	60.20 ± .25
K	5.420 ± 0.020	137.69 ± .50
L	5.565 ± 0.010	141.35 ± .25
M	5.968 ± 0.035	151.58 ± .90
N	.190 ± 0.015	4.826 ± .38
P	.347 ± 0.015	8.81 ± .38
R	1.725 ± 0.010	43.82 ± .25
S	4.100 ± 0.010	104.14 ± .25
T	.190 ± 0.010	4.83 ± .25
U	0.015 max	0.381 max
V	0.265 ± 0.020	8.50 ± .50
W	2.145 ± 0.010	54.48 ± .25
Z	1.755 ± 0.010	44.58 ± .25

Figure 11. Mounting configuration dimensions

7.6.1 Drive orientation

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

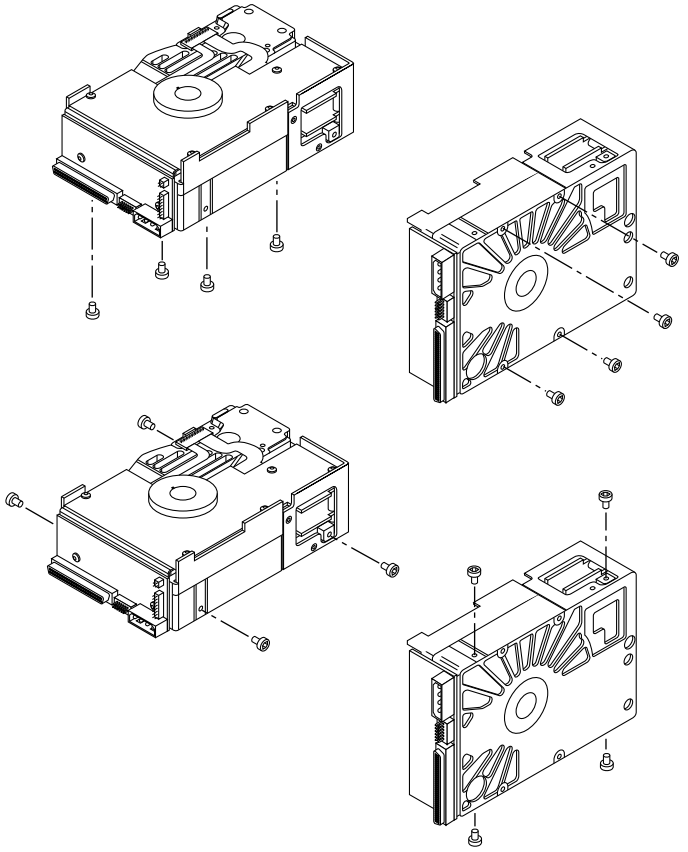


Figure 12. Recommended mounting

7.6.2 Cooling

Ensure that the enclosure you use provides adequate cooling so that the ambient temperature immediately surrounding the drive does not exceed temperature conditions specified in Section 7.4.1. Ensure that you provide adequate air circulation around the printed circuit boards (PCBs) to meet the requirements of Section 6.2.2.

8.0 Media characteristics

This section provides information regarding the media used in Barracuda 2, 2HP disc drives.

8.1 Media description

The media used on the drive has a diameter of approximately 95 mm (3.7 inches). The aluminum substrate is coated with a thin-film magnetic material, which has a proprietary protective layer for improved durability and environmental protection.

9.0 Defect and error management

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

Defect and error management in the SCSI system involves the drive's internal defect/error management and SCSI system error considerations (errors in communications between the initiator and the drive). Tools for designing a defect/error management plan are briefly outlined in this section. References to other sections are provided when necessary.

9.1 Defects and errors

Identified defects are recorded on the drive's defects list (referred to as the primary or ETF defect list). These known defects are reallocated during the initial drive format at the factory. (See Format Unit command Section 5.2.1.2 in the *SCSI-2 Interface Product Manual,* part number 77738479.) Data correction by ECC recovers data from additional flaws if they occur.

Details of the SCSI commands supported by the drive are described in the *SCSI-2 Interface Product Manual.* Also, more information about the drive's Error Recovery philosophy is presented in Section 6 of the *SCSI-2 Interface Product Manual.*

10.0 Option/configuration headers

This section describes how to configure Barracuda 2, 2HP drives using the option headers on the drives. These option headers may be used to customize many functions of the drives for your particular system.

10.1 Drive ID/option select headers

The headers described in this section enable you to configure the drive to meet specific functionality requirements.

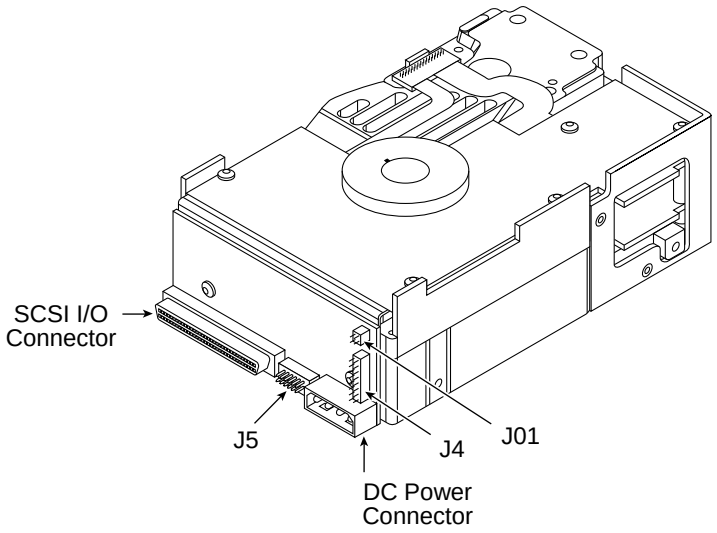


Figure 13. Barracuda 2, 2HP drive physical interface

Figure 14 illustrates the drive's ID and option select jumper connectors.

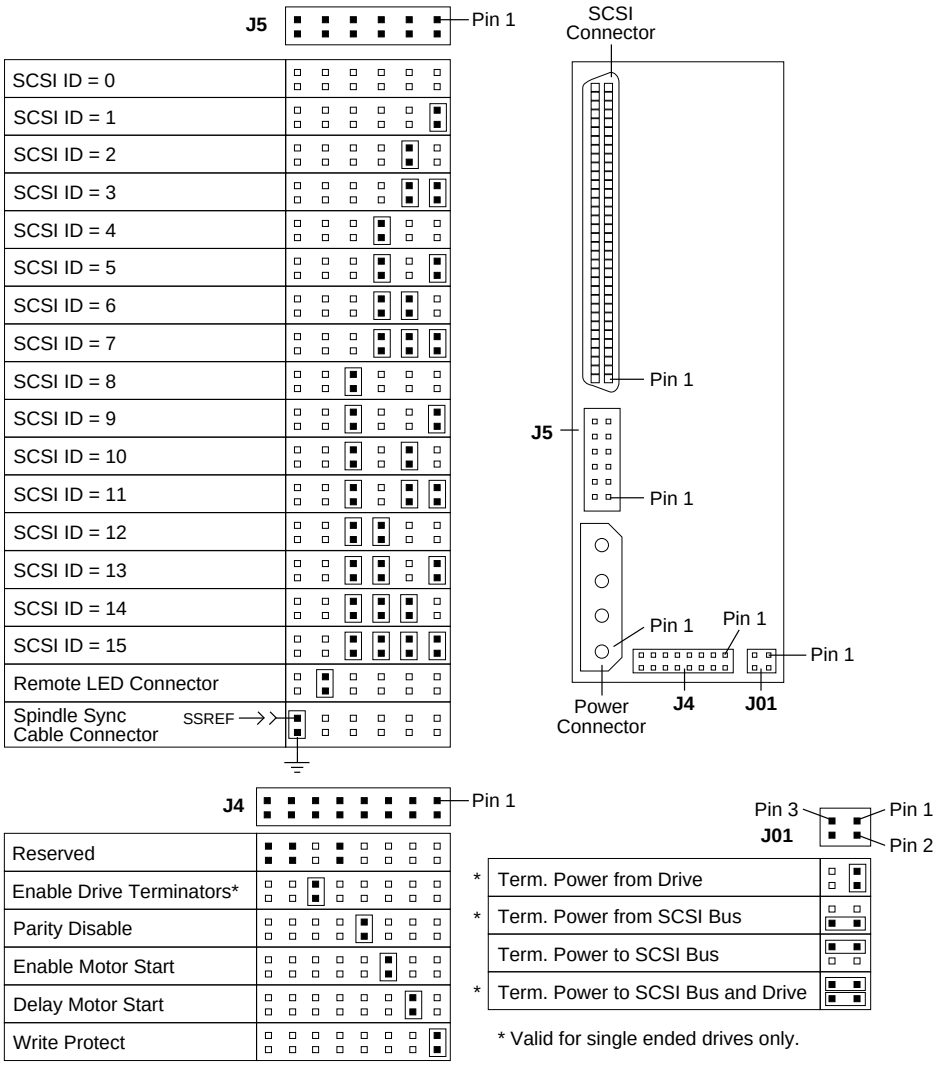


Figure 14. Barracuda drive ID and option select headers

Block	Pins	Function
J01	1&2*	Terminator power supplied by the drive.
	2&4*	Terminator power supplied from the SCSI bus.
	1&3	Terminator power supplied to the SCSI bus.
	1&3 and 2&4*	Terminator power supplied to the SCSI bus and drive.
J4	1&2	Write Protect option. Jumper installed protects the entire disc drive. Default is no jumper.
	3&4	Delay Motor Start option. Jumper installed waits for ten (10) seconds for each target ID number plus a maximum power-up delay of 3 seconds before starting the spindle motor automatically. Default is no jumper. Example: If target ID is equal to two (2) (2 x 10) + 3 = 23 Target spindle motor starts in twenty-three (23) seconds.
	5&6	Enable Motor Start option. Jumper installed causes the target to wait for the Start Unit command from the SCSI host. No jumper installed causes the unit to look at the Delay Motor Start jumper. Default is no jumper.
	7&8	Parity Disable option. Jumper installed causes parity checking and error reporting to be disabled. Default is no jumper.
	9&10	Reserved. Default is no jumper.
	11&12*	Enable Single-Ended Drive Terminator. Jumper installed enables the drive terminator. Jumper removed disables the drive terminator. Default is no jumper.
	13&14	Reserved. Default is no jumper.
	15&16	Reserved. Default is no jumper.
J5	1&2**	SCSI Target ID 0
	3&4**	SCSI Target ID 1
	5&6**	SCSI Target ID 2
	7&8**	SCSI Target ID 3
	9&10	Remote LED connector. Pin 9 is cathode (neg), Pin 10 is anode (pos). Pin 10 is current limited through a 1K ohm, 1/10W resistor.
	11&12	Spindle sync cable connector. Pin 11 is the SSREF+ or reference index signal. Pin 12 is Gnd.

* Valid for single-ended (ST12450W) drives only.
** See Figure 14 to set the SCSI ID.

10.2 Synchronized spindles interface

The synchronized spindles interface (SSI) allows several drives operating from the same host to operate their spindles at a synchronized rotational rate. Details of the electrical and physical interfaces follow in Sections 10.2.1, 10.2.1.2, and 10.2.1.3. The system operation is described in Section 5.7.

10.2.1 Electrical description

The electrical interface consists of one digital TTL reference index signal and ground. The reference index signal (SSREF+) is an output if the drive is configured as a master and is an input otherwise. The reference index signal is connected from drive to drive in a daisy-chain fashion as shown in Figure 4.

10.2.1.1 Drivers and receivers

Figure 15 shows a diagram of the driver/receiver circuit. The ST12450W/WD use J5 pins 11 and 12 for spindle sync reference. The driver circuits have the following electrical specifications:

Negated (false): 0.V to +0.4V @ I = –24 mA (max)
Asserted (true): +2.24V to +5.25V @ I = +250 µA

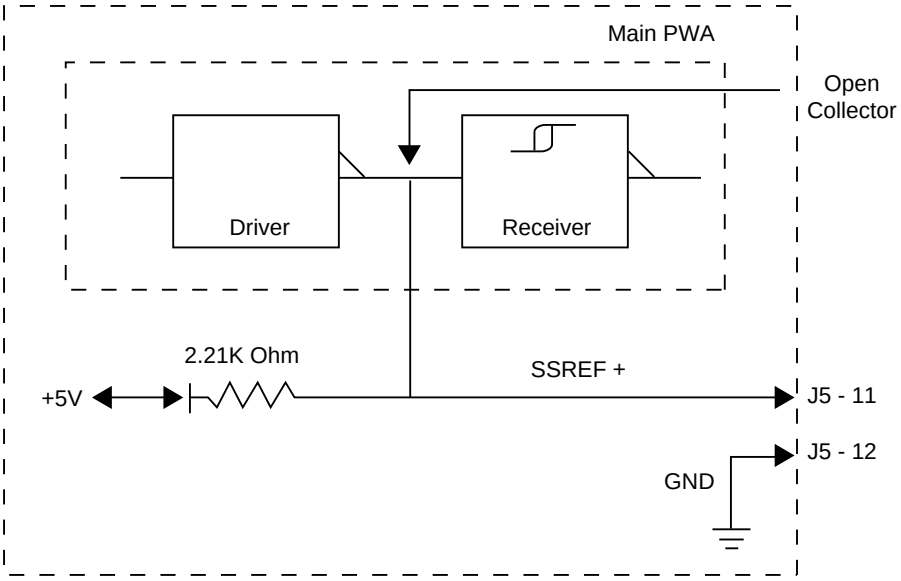


Figure 15. SCSI reference index signal driver/receiver combination

10.2.1.2 Termination

The reference index signal (SSREF+) is terminated with a 2.21K ohm resistor. Each single-ended drive has a terminator resistor located on the main PCB. The terminator resistor is not removable and is always in the circuit; however, you can disable termination by using a jumper option. See Section 10.1. There is no provision for internal termination on differential models. See Section 11.7.3.2. A diode prevents current from backfeeding.

10.2.1.3 Physical interface

The dimensions of the J5 connector mounted on the main PCB to interconnect the drives are shown in Figure 16. It is a 12-pin, 6-position gold 2 mm header type connector. Only pins 11 and 12 are used for connecting the reference index signal cable, as shown in Figure 14. Pin 11 is SSREF+ and pin 12 is ground.

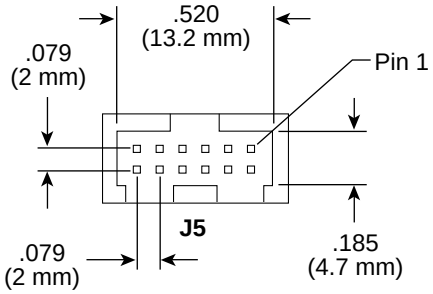


Figure 16. J5 configuration select header specification

10.3 Grounding

Signal ground (PCB) and HDA ground are connected together in the Barracuda 2, 2HP family drives—do not separate this connection. Maximizing the conductive contact area between HDA ground and system ground may reduce radiated emissions. A bracket shield with tapped holes is available to system integrators. This shield makes it easier to attach a braid or similar high-frequency grounding device. If you do not want the system chassis to be connected to the HDA/PCB ground, you must provide a nonconductive (electrically isolating) method of mounting the drive in the host equipment; however, this may increase radiated emissions and is the system designer's responsibility.

11.0 Interface requirements

This section describes the Barracuda 2, 2HP interface requirements.

11.1 General description

The major portion of the interface requirements/implementation is described in the *SCSI-2 Interface Product Manual* (part number 77738479).

11.2 SCSI interface messages supported

Table 2 lists the messages supported by the Barracuda SCSI-1 and SCSI-2 modes.

Table 2. SCSI messages supported

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

*** Extended messages (see the *SCSI-2 Interface Product Manual)*

11.3 SCSI interface commands supported

Table 3 lists the SCSI interface commands supported in SCSI-1 and SCSI-2 modes. Barracuda 2, 2HP family drives can be changed back and forth between SCSI-1 and SCSI-2 modes using the Change Definition command. Standard OEM drives are shipped set to operate in SCSI-2 mode.

Table 3. Supported commands

Command code	Supported by: SCSI-1	SCSI-2	Command name
00h	Y	Y	Test Unit Ready
01h	Y	Y	Rezero Unit
03h	Y	Y	Request Sense
	Y	Y	Extended Sense
	Y	Y	Field Pointer Bytes
	N	N	Actual Retry Count Bytes
04h	Y	Y	Format Unit [1]
07h	Y	Y	Reassign Blocks
08h	Y	Y	Read
0Ah	Y	Y	Write
0Bh	Y	Y	Seek
12h	Y	Y	Inquiry
	N	Y	Vital Product Data Page
	N	Y	Unit Serial Number Page
	N	Y	Implemented Operating Def. Page
	N	Y	Firmware Numbers Page
	N	Y	Date Code Page
	N	Y	Jumper Settings Page
15h	Y	Y	Mode Select (same pages as Mode Sense command shown below)
16h	Y	Y	Reserve
	Y	Y	3rd Party Reserve
	N	N	Extent Reservation
17h	Y	Y	Release
18h	N	N	Copy
1Ah	Y	Y	Mode Sense
	Y	Y	Unit Attention Page (00h)
	Y	Y	Error Recovery Page (01h)
	Y	Y	Disconnect/Reconnect Control (page 02h)
	Y	Y	Format Page (03h)
	Y	Y	Rigid Disc Drive Geometry Page (04h)
	N	Y	Verify Error Recovery Page (07h)
	N	Y	Caching Parameters Page (08h)
	N	Y	Control Mode Page (0Ah)
	N	Y	Notch and Partition Page (0C) (media zones)
1Bh	Y	Y	Start Unit/Stop Unit

continued

continued from previous page

Command code	Supported by: SCSI-1	SCSI-2	Command name
1Ch	Y	Y	Receive Diagnostic Results
	Y	Y	Supported Diagnostics Pages
	Y	Y	Translate Page
1Dh	Y	Y	Send Diagnostics Page
	Y	Y	Supported Diagnostics Pages
	Y	Y	Translate Page
25h	Y	Y	Read Capacity
28h	Y	Y	Read Extended
2Ah	Y	Y	Write Extended
2Bh	Y	Y	Seek Extended
2Eh	Y	Y	Write and Verify
2Fh	Y	Y	Verify
30h	N	N	Search Data High
31h	N	N	Search Data Equal
32h	N	N	Search Data Low
33h	N	N	Set Limits
34h	N	N	Prefetch
35h	N	Y	Synchronize Cache
36h	N	N	Lock-Unlock-Cache
37h	Y	Y	Read Defect Data
39h	N	N	Compare
3Ah	N	N	Copy and Verify
3Bh	Y	Y	Write Buffer [2]
3Ch	Y	Y	Read Buffer [2]
3Eh	Y	Y	Read Long
3Fh	Y	Y	Write Long
40h	Y	Y	Change Definition
41h	N	N	Write Same
42-4Bh	N	N	Not used
4Ch	N	N	Log Select
4Dh	N	N	Log Sense
4E-54	N	N	Not used
55h	N	Y	Mode Select (10)
56h	N	Y	Reserve (10)
57h	N	Y	Reserve (10)
58-59	N	N	Not used
5Ah	N	Y	Mode Sense (10)
5B-5F	N	N	Not used
60-BFh	N	N	Not used
C0-DFh	N	N	Not used
EO-FFh	N	N	Not used

[1] Format to any even number of bytes per sector from 180 to 4,096.

[2] If cache is enabled (RCD = 0 in Mode Sense page 08h), byte transfer length is 976,896 bytes plus a 4-byte header.

If cache is disabled (RCD = 1), byte transfer length is 976,896 bytes plus a 4-byte header.

11.3.1 Inquiry data

Table 4 lists the Inquiry command data that the drive should return to the initiator per the format provided in the *SCSI-2 Interface Product Manual.*

Table 4. Barracuda 2, 2HP family drive inquiry data

Bytes	Data (hex)																
0-15	00	00	**	***	8F	00	00	3A	53	45	41	47	41	54	45	20	Vendor ID
16-31	53	54	[31	32	34	35	30	57]	20	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*	34*	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	
144-147	D#	D#	D#	D#													

* Copyright year (changes with actual year).

** 01 = SCSI-1 implemented.
02 = SCSI-2 implemented (default).
The drive can be changed between these two configurations.

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

R# Four ASCII digits representing the last four digits of the product firmware release number.

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

D# Reserved 0000.

[ ] Bytes 18 through 23 reflect the model of the drive (ST12450W shown).

11.3.2 Mode sense data

The following tables list the data-byte values the drive returns in response to the Mode Sense command pages for SCSI-1 and SCSI-2 implementations (see the *SCSI-2 Interface Product Manual).*

Definitions:

DEF = Default value. Standard drives are shipped configured this way.

CHG = Changeable bits; indicates if default value is changeable.

Table 5. Mode sense data, Barracuda 2, 2HP default values (SCSI-1 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	63	00	10	08																				
	00	37	1B	38	00	00	02	00																
	<——————————Mode page headers and parameter data bytes——————————>																							
Mode Page																								
DEF																								
01	81	06	04	1B	30	00	00	FF																
CHG																								
01	81	06	EF	FF	00	00	00	00																
DEF																								
02	82	0A	80	80	00	0A	00	00	00	00	00	00												
CHG																								
02	82	0A	FF	FF	00	00	00	00	00	00	00	00												
DEF																								
03	83	16	00	09	00	09	00	00	00	09	00	95	02	00	00	01	00	0D	00	1C	40	00	00	00
CHG																								
03	83	16	FF	FF	FF	FF	00	00	FF	FF	00	00	00	00	00	00	00	00	00	00	00	00	00	00
DEF																								
04	84	12	00	0A	97	09	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
CHG																								
04	84	12	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	03	FF	00				
DEF																								
08	88	12	10	00	FF	FF	00	00	00	9F	02	7C	80	03	00	00	00	00	00	00				
CHG																								
08	88	12	BD	00	00	00	FF	FF	FF	FF	00	00	AD	FF	00	00	00	00	00	00				
DEF																								
00	80	02	00	00																				
CHG																								
00	80	02	76	00																				

Table 6. Mode sense data, Barracuda 2, 2HP default values (SCSI-2 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	3F	1B	38	00	00	02	00																
	<——————————Mode page headers and parameter data bytes——————————>																							
Mode Page																								
DEF																								
01	81	0A	04	1B	30	00	00	00	03	00	FF	FF												
CHG																								
01	81	0A	EF	FF	00	00	00	00	FF	00	00	00												
DEF																								
02	82	0E	80	80	00	0A	00	00	00	00	00	00	00	00	00	00								
CHG																								
02	82	0E	FF	FF	00	00	00	00	00	00	00	00	83	00	00	00								
DEF																								
03	83	16	00	09	00	09	00	00	00	09	00	95	02	00	00	01	00	0D	00	1C	40	00	00	00
CHG																								
03	83	16	FF	FF	FF	FF	00	00	FF	FF	00	00	00	00	00	00	00	00	00	00	00	00	00	00
DEF																								
04	84	16	00	0A	97	09	00	00	00	00	00	00	00	00	00	00	00	00	00	00	1C	20	00	00
CHG																								
04	84	16	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	03	FF	00	00	00	00	00
DEF																								
07	87	0A	00	1B	30	00	00	00	00	00	FF	FF												
CHG																								
07	87	0A	0F	FF	00	00	00	00	00	00	00	00												
DEF																								
08	88	12	10	00	FF	FF	00	00	00	9F	02	7C	80	03	00	00	00	00	00	00				
CHG																								
08	88	12	BD	00	00	00	FF	FF	FF	FF	00	00	A0	FF	00	00	00	00	00	00				
DEF																								
0A	8A	0A	00	10	00	00	00	00	00	00	00	00												
CHG																								
0A	8A	0A	03	01	00	00	00	00	00	00	00	00												
DEF																								
0C	8C	16	80	00	00	18	00	00	00	00	00	00	00	0A	96	08	00	00	00	00	00	00	10	00
CHG																								
0C	8C	16	04	00	00	00	FF	FF	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
DEF																								
00	80	02	00	00																				
CHG																								
00	80	02	76	00																				

11.4 SCSI bus conditions and miscellaneous features supported

Asynchronous SCSI bus conditions supported by the drive are listed in Table 7. These conditions cause the SCSI device to perform certain actions and can alter the phase sequence. Other miscellaneous operating features supported are also listed here.

Table 7. SCSI bus conditions and other miscellaneous features

Condition/feature supported by:		
SCSI-1	**SCSI-2**	**Conditions or feature**
Y	Y	Attention condition
Y	Y	Reset condition
N	Y	Contingent allegiance condition
N	Y	Asynchronous event notification
Y	Y	Arbitrating system
Y	Y	Disconnect/reconnect
Y	Y	Asynchronous data transfer
Y	Y	Synchronous data transfer
Y	Y	Synchronized (locked) spindle operation
Y	Y	Differential interface circuits available
Y	Y	Segmented caching
N	N	Zero latency read
N	Y	Queue tagging (up to 64 queue tags supported)
N	Y	Deferred error handling
Y	Y	Parameter rounding (controlled by round bit in Mode Select page 0)
N	Y	Reporting actual retry count in extended sense bytes 15,16, and 17
N	N	Adaptive caching
Y	Y	Adaptive read lookahead
Y	Y	SMP = 1 in Mode Select command needed to save RPL and rotational offset bytes (in Table 5.2.1-25 of *SCSI-2 Interface Product Manual, Vol. 2).*

SCSI-1	**SCSI-2**	**Status supported**
Y	Y	Good
Y	Y	Check condition
Y	Y	Condition met/good
Y	Y	Busy
Y	Y	Intermediate/good
Y	Y	Intermediate/condition met/good
Y	Y	Reservation conflict
Y	Y	Queue full

11.5 Synchronous data transfer

The data transfer period to be used by the drive and the initiator is established by an exchange of messages during the Message Phase of operation. See the section on message protocol in the *SCSI-2 Interface Product Manual.*

11.5.1 Synchronous data transfer periods supported

Table 8 lists the synchronous data transfer periods supported by the drive.

Table 8. Synchronous data transfer periods

M (decimal)	Transfer period (M times 4 nanoseconds)	Transfer rate (mega transfers/second)
25	100	10.0
31	125	8.0
37	150	6.66
50	200	5.0
62	250	4.00
75	300	3.33
87	350	2.86
100	400	2.5

11.5.2 REQ/ACK offset

The maximum REQ/ACK offset supported by Barracuda drives is 15 (0Fh).

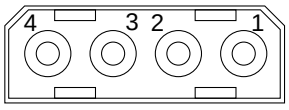
11.6 DC cable and connector

The drive receives DC power through a 4-pin connector mounted at the rear of the main PCB (see Figure 17). Recommended part numbers of the mating connector are listed below, but equivalent parts may be used.

Table 9. Mating connector parts

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

Note. The output of a power supply must meet SELV (safety extra low voltage), as defined in IEC 950.



Pins
1 +12V DC
2 +12V DC return
3 +5V DC return
4 +5V DC

11.7 SCSI physical interface

Figure 17 shows the locations of the physical interface components for the drive. Locations of the DC power connector, the SCSI interface connector, the I/O line terminators, and the drive select and option select headers are shown.

Details of the physical, electrical, and logical characteristics are given below. The SCSI operational aspects of Seagate drive interfaces are provided in the *SCSI-2 Interface Product Manual.*

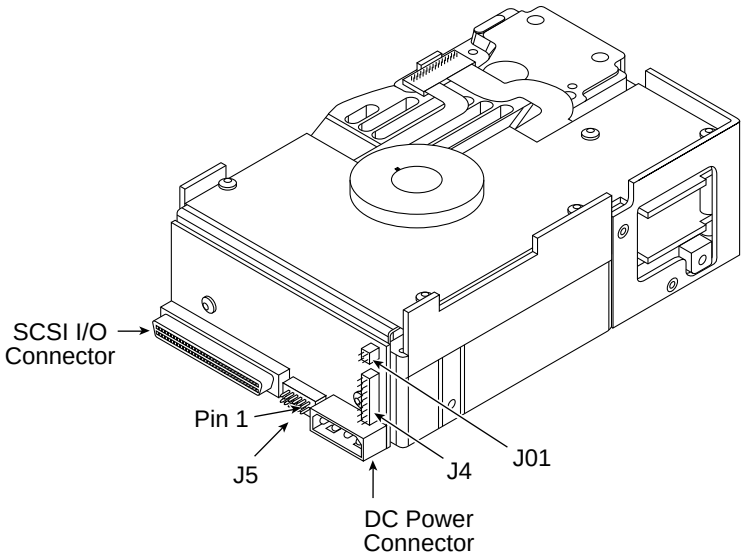


Figure 17. Barracuda 2, 2HP physical interface

11.7.1 Physical characteristics

This section defines the connectors, cables, signals, terminators and bus timing needed to implement the SCSI interface.

11.7.1.1 Physical description

You can daisy-chain multiple SCSI devices on a common cable if each device has the same type of drivers and receivers (all single-ended or all differential). Devices having single-ended interface circuits cannot be on the same daisy chain with devices having a differential interface circuit. Both ends of the cable must be terminated. All signals are common between SCSI devices. A maximum of 16 SCSI devices (including the host) may be daisy-chained together.

Terminate both ends of the daisychain, but do not terminate any intermediate SCSI device. The ST12450W drives are equipped with permanently mounted IC terminators, which you can turn on or off using the Enable Drive Terminator jumper on pins 11 and 12 of J4. The differential (ST12450WD) drives do not have on-board terminators.

11.7.1.2 Cable requirements

Sections 11.7.1.2.1, 11.7.1.2.2, and 11.7.1.2.3 describe the single-ended, differential, and general cable requirements for Barracuda 2, 2HP drives.

11.7.1.2.1 Single-ended I/O circuits

The maximum total cable length for use with drives having single-ended I/O driver and receiver circuits is 6 meters (19.7 feet) when operating at line data transfer rates of 5 Mbytes/second or less, and 3 meters (9.85 feet) when operating at transfer rates greater than 5 Mbytes/second (fast SCSI). A stub length of no more than 0.1 meter (0.33 feet) is allowed off the mainline interconnection with any connected equipment. An ideal impedance match with cable terminators implies a cable characteristic impedance of 132 ohms. Single-ended I/O cable pin assignments for ST12450W drives are shown in Table 10.

11.7.1.2.2 Differential I/O circuits

The maximum total cable length for use with drives having differential I/O drivers and receiver circuits is 25 meters (82 feet). A stub length of no more than 0.2 meter (0.66 foot) is allowed off the mainline interconnection with any connected equipment. An ideal impedance match with cable terminators implies a cable characteristic impedance of 122 ohms. Differential I/O cable pin assignments for ST12450WD drives are shown in Table 11.

11.7.1.2.3 General cable characteristics

In general, cables having the characteristic impedances given in Sections 11.7.1.2.1 and 11.7.1.2.2 are not available; however, impedances that are lower are satisfactory. A characteristic impedance of 100 ohm +10% is recommended for unshielded flat or twisted-pair ribbon cable. To minimize discontinuities and signal reflections, cables of different impedances should not be used in the same bus. Your specific setup may require tradeoffs 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 to maintain adequate margin at fast SCSI transfer rates.

11.7.2 Connector requirements

Recommended mating wide cable connectors part numbers:

AMP 786096-7, female 68-pin
AMP 786090-7, male 68-pin

11.7.3 Electrical description

ST12450W drives use single-ended interface signals. These signals must be terminated with 110 ohm active terminator circuits at each end of the total cable. Single-ended circuits use open collector or three-state drivers. ST12450W drives can be configured to provide the SCSI termination.

ST12450WD drives use differential interface signals. Each of these signals 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 and have no provisions for adding terminator sockets on the PCB. You must provide external termination for these drives.

11.7.3.1 Single-ended drivers/receivers

Typical single-ended driver and receiver circuits for the Barracuda 2, 2HP family are shown in Figure 18. Terminator circuits shown are needed only when the disc drive is first or last on the daisy chain. (See Note 1 following Figure 18.)

Note. All single-ended terminators must be ANSI SCSI-2 alternative 2 active terminators.

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 0.4V.

Receiver characteristics

Single-ended drives use an ANSI SCSI single-ended receiver with hysteresis gate or equivalent as a line receiver.

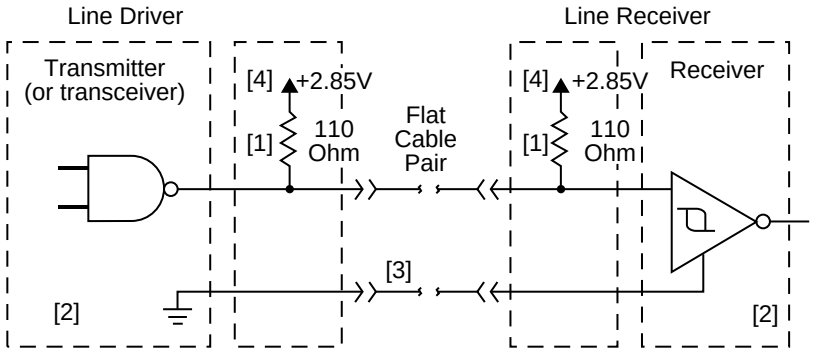


Figure 18. Single-ended transmitters and receivers

Notes:

[1] Part of active terminator circuits. Enable drive termination when it is first or last on the daisy chain.

Interface signal levels and logical sense at the drive I/O connector are defined as follows:

Logic level	Driver output	Receiver input
Negated (0)	≥ 2.5V : ≤ 5.25V	≥ 2.0V : < 5.25V
Asserted (1)	≤ 0.4V : ≥ 0.0V	≤ 0.8V : > 0.0V

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

[2] ANSI SCSI compatible circuits.

[3] Total interface cable length should not exceed that specified in Section 11.7.1.2.1.

[4] Source of drive terminator power is VR1 which has an input source voltage selected by a jumper.

11.7.3.2 Differential drivers/receivers

Typical differential driver and receiver circuits used by ST12450WD drives are shown in Figure 19. The differential drives have no provisions for terminator circuits.

Differential signals

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

Output characteristics

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

Low-level output voltage*

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

High-level output voltage*

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

Differential voltage

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

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

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

Input characteristics

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

Input current on either input

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

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

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

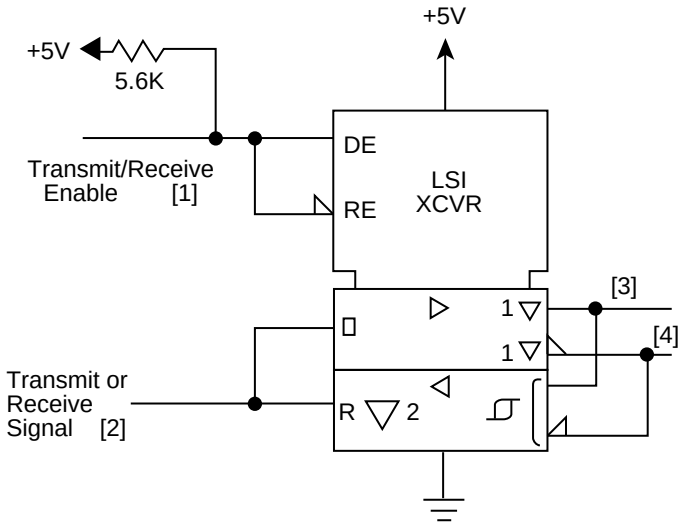


Figure 19. Typical differential I/O line transmitter/receiver and terminators

Notes:

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

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

[3] Total interface cable length should not exceed 82.1 feet (25 meters) from the host to the end of the daisy chain.

[4] You must provide terminators.

11.7.3.3 Terminator requirements

ST12450W

Internal disc drive I/O termination consists of 110 ohm active terminator circuits contained in permanently mounted IC terminator packs on the main PCB. All single initiator/single target (non-daisy-chain) applications require you to terminate the initiator and drive.

You must terminate both ends of the SCSI bus with ANSI SCSI-2 standard alternative 2 (active) termination, especially if the bus operates at fast SCSI transfer rates.

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

Note. Remove the Enable Drive Terminator jumper on J4 pins 11 and 12 when terminators are not required.

ST12450WD

Differential I/O Barracuda drives do not have provisions to add terminator sockets on the PCB. You must provide external termination.

11.7.3.4 Terminator power

The drive may be configured to accept terminator power using pins 51 and 52 of the SCSI bus to supply power to the SCSI bus or to provide terminator power for optional internal termination resistors using the drive's power connector (see Figure 14). The drive can provide power both to its own terminators and to the SCSI bus terminator power line.

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

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

11.8 SCSI wide physical interface

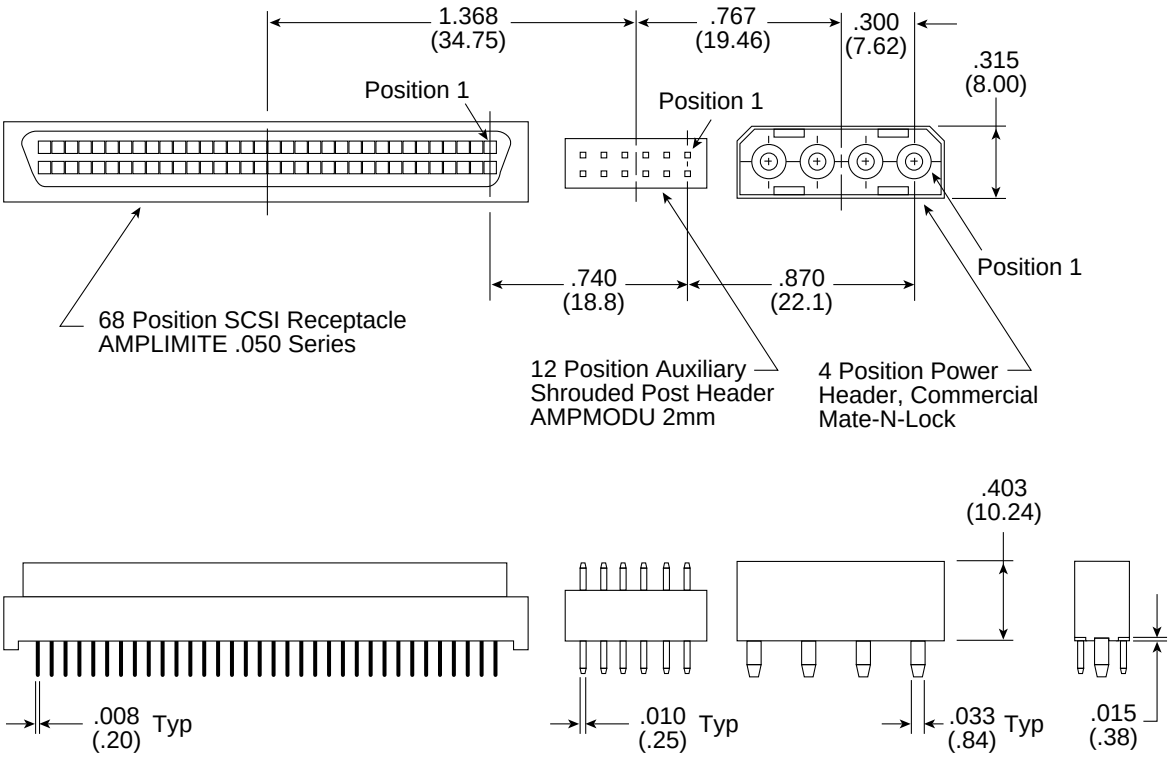


Figure 20. Wide SCSI device connector

Table 10. Single-ended contact assignments (P cable) for ST12450W drives

Signal name	Connector contact number	Connector contact number	Signal name
GROUND	1	35	–DB (12)
GROUND	2	36	–DB (13)
GROUND	3	37	–DB (14)
GROUND	4	38	–DB (15)
GROUND	5	39	–DB (P1)
GROUND	6	40	–DB (0)
GROUND	7	41	–DB (1)
GROUND	8	42	–DB (2)
GROUND	9	43	–DB (3)
GROUND	10	44	–DB (4)
GROUND	11	45	–DB (5)
GROUND	12	46	–DB (6)
GROUND	13	47	–DB (7)
GROUND	14	48	–DB (P)
GROUND	15	49	GROUND
GROUND	16	50	GROUND
TERMPWR	17	51	TERMPWR
TERMPWR	18	52	TERMPWR
RESERVED	19	53	RESERVED
GROUND	20	54	GROUND
GROUND	21	55	–ATN
GROUND	22	56	GROUND
GROUND	23	57	–BSY
GROUND	24	58	–ACK
GROUND	25	59	–RST
GROUND	26	60	–MSG
GROUND	27	61	–SEL
GROUND	28	62	–C/D
GROUND	29	63	–REQ
GROUND	30	64	–I/O
GROUND	31	65	–DB (8)
GROUND	32	66	–DB (9)
GROUND	33	67	–DB (10)
GROUND	34	68	–DB (11)

Notes:

1. The hyphen preceding a signal name indicates that signal is active low.
2. 8-bit devices that connect to the P cable should leave the following signals open: DB(8) –DB(9) –DB(10) –DB(11) –DB(12) –DB(13) –DB(14) –DB(15) –DB(P1). All other signals should be connected as defined.

Table 11. Differential contact assignments (P cable) for ST12450WD drives

Signal name	Connector contact number	Connector contact number	Signal name
DB (12)	1	35	–DB (12)
DB (13)	2	36	–DB (13)
DB (14)	3	37	–DB (14)
DB (15)	4	38	–DB (15)
DB (P1)	5	39	–DB (P1)
GROUND	6	40	GROUND
DB (0)	7	41	–DB (0)
DB (1)	8	42	–DB (1)
DB (2)	9	43	–DB (2)
DB (3)	10	44	–DB (3)
DB (4)	11	45	–DB (4)
DB (5)	12	46	–DB (5)
DB (6)	13	47	–DB (6)
DB (7)	14	48	–DB (7)
DB (P)	15	49	–DB (P)
DIFFSENS	16	50	GROUND
TERMPWR	17	51	TERMPWR
TERMPWR	18	52	TERMPWR
RESERVED	19	53	RESERVED
ATN	20	54	–ATN
GROUND	21	55	GROUND
BSY	22	56	–BSY
ACK	23	57	–ACK
RST	24	58	–RST
MSG	25	59	–MSG
SEL	26	60	–SEL
C/D	27	61	–C/D
REQ	28	62	–REQ
I/O	29	63	–I/O
GROUND	30	64	GROUND
DB (8)	31	65	–DB (8)
DB (9)	32	66	–DB (9)
DB (10)	33	67	–DB (10)
DB (11)	34	68	–DB (11)

Notes:

1. The hyphen preceding a signal name indicates that signal is active low.
2. 8-bit devices that connect to the P cable should leave the following signals open: –DB(12) –DB(13) –DB(14) –DB(15) –DB(P1) –DB(8) –DB(9) –DB(10) –DB(11) DB(12) DB(13) DB(14) DB(15) DB(P1) DB(8) DB(9) DB(10) DB(11). All other signals should be connected as defined.

Table 12. Disc drive SCSI timing

Description	Waveform symbol [1]	Waveform table [1]	Typical	Max
Target select time (no arbitration)	T00	N/A	< 1 µs	< 250 µs
Target select time (with arbitration)	T01	4.5-1,2	2.31 µs	2.36 µs
Target select to command	T02	4.5-1	3.33 µs	3.34 µs
Target select to MSG out	T03	4.5-2	1.51 µs	1.54 µs
Identify MSG to command	T04	4.5-3	3.34 µs	3.36 µs
Command to status	T05	4.5-5	Command dependent	
Command 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	0.64 µs	0.68 µs
Disconnect to arbitration (for re-select)	T11	4.5-6	Command dependent	
This measures disconnected CMD overhead				
Target win arbitration (for re-select)	T12	4.5-7		2.8 µs
Arbitration to re-select	T13	4.5-7		1.8 µs
Re-select to Identify MSG in	T14	4.5-7		1.34 µs
Re-select Identify MSG to status	T15	4.5-8	Command dependent	
Re-select 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		1.0 µs
Command complete MSG to bus free	T19	4.5-5,8,15		0.75 µs
Data to save data pointer MSG	T20	4.5-14		4.5 µs
Save data pointer MSG to disconnect MSG	T21	4.5-14		0.75 µs
Command byte transfer	T22	4.5-4		0.04
Next command byte access		4.5-4		
Next CDB byte access (byte 2 of 6)	T23.6.2	4.5-4	0.55 µs	0.56 µs
Next CDB byte access (byte 3 of 6)	T23.6.3	4.5-4	0.10 µs	0.10 µs
Next CDB byte access (byte 4 of 6)	T23.6.4	4.5-4	0.09 µs	0.10 µs
Next CDB byte access (byte 5 of 6)	T23.6.5	4.5-4	0.13 µs	0.14 µs
Next CDB byte access (byte 6 of 6)	T23.6.6	4.5-4	0.13 µs	0.14 µs
	T33			
	T34			
Next CDB byte access (byte 2 of 10)	T23.10.2	4.5-4	0.59 µs	0.60 µs
Next CDB byte access (byte 3 of 10)	T23.10.3	4.5-4	0.14 µs	0.14 µs
Next CDB byte access (byte 4 of 10)	T23.10.4	4.5-4	0.13 µs	0.14 µs
Next CDB byte access (byte 5 of 10)	T23.10.5	4.5-4	0.12 µs	0.12 µs
Next CDB byte access (byte 6 of 10)	T23.10.6	4.5-4	0.11 µs	0.12 µs
Next CDB byte access (byte 7 of 10)	T23.10.7	4.5-4	0.10 µs	0.10 µs
Next CDB byte access (byte 8 of 10)	T23.10.8	4.5-4	0.09 µs	0.10 µs
Next CDB byte access (byte 9 of 10)	T23.10.9	4.5-4	0.13 µs	0.14 µs
Next CDB byte access (byte 10 of 10)	T23.10.10	4.5-4	0.12 µs	0.12 µs

continued

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

Notes:

[1] See the *SCSI-2 Interface Product Manual* (part number 77738479), Section 4.5.

[2] Maximum SCSI asynchronous interface transfer rate is given in Section 5.3.

[3] Synchronous transfer period is determined by negotiations between an initiator and a drive. The drive is capable of setting periods as given in Section 11.5 in this manual. See also Sections 3.1.5.2 and 3.5.3.2 of the *SCSI-2 Interface Product Manual* for a description of synchronous data transfer operation.

General timing diagrams for SCSI interface operation are shown in the *SCSI-2 Interface Product Manual,* Section 4.5.

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Seagate Technology, Inc.
920 Disc Drive, Scotts Valley, California 95066-4544, USA

Publication Number: 83328900, Rev. B, Printed in USA