Seagate

Barracuda 4 Disc Drive

ST15150N/ND

ST15150W/WD/WC/DC

Product Manual, Volume 1

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Seagate

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Note. Product Manual 83328880 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™ 4 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 4 drives. The *SCSI-2 Interface Product Manual* (part number 77738479) describes the general SCSI interface characteristics of this and other families of Seagate drives.

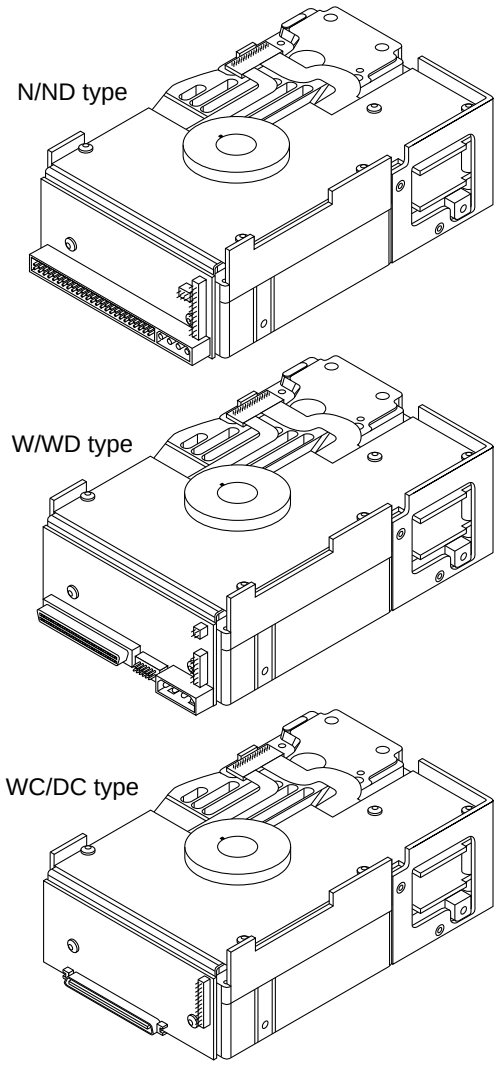


Figure 1. Barracuda 4 disc drives

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.

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.

Seagate uses an independent laboratory to confirm compliance to the above directives. Drives are tested in representative systems 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

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

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 4 Installation Guide
Seagate part number: 83328870

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 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.

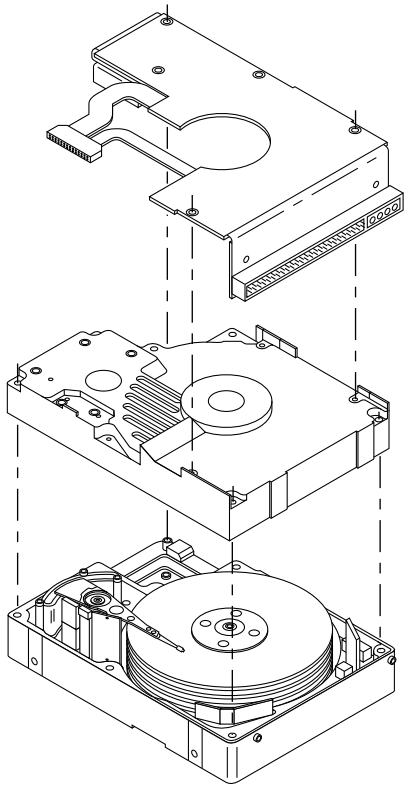


Figure 2. Barracuda 4 disc drive (exploded view)

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 4 drives have the following standard features:

- 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
- Active termination for single-ended models
- 1,024 Kbyte data buffer (see Section 5.5)

4.1 Performance

- 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

- 800,000 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 512 bytes per block.

ST15150 drives have nine (9) spare sectors per cylinder and one (1) spare cylinder per unit.

Formatted	Unformatted
4,294 Mbytes	5,062 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 following items are incorporated at the time of production or are available as accessories. All kits may be installed in the field.

- Front panel kit (green lens), part number 70869751
- Single-unit shipping pack kit
- *Barracuda 4 Installation Guide,* part number 83328870
- Adapter accessory frame kit, part number 75790701 (adapts a 3.5-inch drive to fit in a 5.25-inch drive mounting space)

4.3.1 Front panel

The front panel normally available 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.

4.3.2 Single-unit shipping pack

The drive is normally 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. Users planning single-unit distribution should specify this option.

4.3.3 *Barracuda 4 Installation Guide*

Part number 83328870

This manual provides basic information about how to install the drive. It also includes information to assist in obtaining service for the drive.

4.3.4 Adaptor 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 form factor. 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 Figures 20, 22, or 24. 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 (ST15150N/W/WC) drives by enabling this feature with a jumper (see Section 10). External terminators are required for differential (ST15150ND/WD/DC) 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 the 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 4 drives.

5.1 Internal drive characteristics

Drive capacity, Mbytes unformatted	5,062
Read/write data heads, maximum (physical)	21
Bytes per track, average bytes	64,160
Bytes per surface, Mbytes unformatted	232.4
Cylinders/tracks per surface, user accessible	3,711
Tracks per inch	4,048
Bits per inch	73,820
Servo heads	1
Internal data rate per physical head, Mbits/sec, variable with zone	47.5 to 72.0
Disc rotation speed	7,200 ± 0.5%
Avg rotational latency, msec	4.17

5.2 SCSI seek performance characteristics

ASA I download code thermal calibration (TCAL)

All performance characteristics assume that thermal calibration is not in process when the drive receives the SCSI command. Thermal calibration will not interrupt an active SCSI command. If thermal calibration is in process when a SCSI command is received, the command is queued until the calibration for the specific head being calibrated completes. When calibration completes for the specific head being calibrated, the first queued SCSI command executes. When execution of the first queued command is complete, the drive continues the calibration for the remaining head.

The above procedure continues until calibration for all heads has completed, or until 10 minutes have elapsed. The drive initiates a thermal calibration 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 thermal calibration cycle approximately once every 10 minutes. Automatic non-interruptible thermal calibration occurs at other times but should be transparent to the user (e.g., during format, Rezero command, at spindle-up, during read error recovery, and during reassign block functions). You can use the Rezero command to reset the thermal calibration timer back to its start so that the host knows when the interruption for thermal calibration will occur.

ASA II download code thermal calibration (TCAL)

1. All heads are thermally calibrated at power-up and following SCSI resets before any read or write commands are processed. All heads are also thermally calibrated during the SCSI Rezero Unit command.
2. The drive then delays a fixed period of time (D) before initiating any further thermal calibrations. This delay provides a guaranteed time interval when no thermal calibration interruptions will occur.
3. A single-head TCAL is scheduled to occur every N1 seconds where:

   N1 = (T – D)/(2 • H)

   T = Maximum allowable thermal calibration period for any single head (600 seconds)

   D = Time delay after the power-up/reset calibration before initiating subsequent thermal calibrations (300 seconds)

   H = Number of heads in the drive (see Section 5.1 “Internal drive characteristics”).
4. After the drive has cycled once through all the heads (H) at the N1 time interval, single-head TCAL scheduling switches to a N2 time interval where: N2 = T/(2 • H).
5. When a single-head TCAL is scheduled, the drive attempts to find an idle period of 25 to 50 milliseconds prior to performing the TCAL. If the TCAL has still not been performed after another N1 or N2 seconds (whichever is the current time interval) the drive forces a TCAL to occur at the next command boundary (even during a read look ahead sequence), and immediately resets the N1 or N2 timer. This guarantees that no head will remain uncalibrated for more than T (600) seconds and that no TCALs will occur closer together in time than approximately N1 or N2 seconds.
6. TCALs performed during the “standard” retry sequence are limited to the failing head, and will be disabled if the host selects a retry count of zero.

Refer to Section 11.11 and to the *SCSI-2 Interface Product Manual* (part number 77738479) for additional timing details.

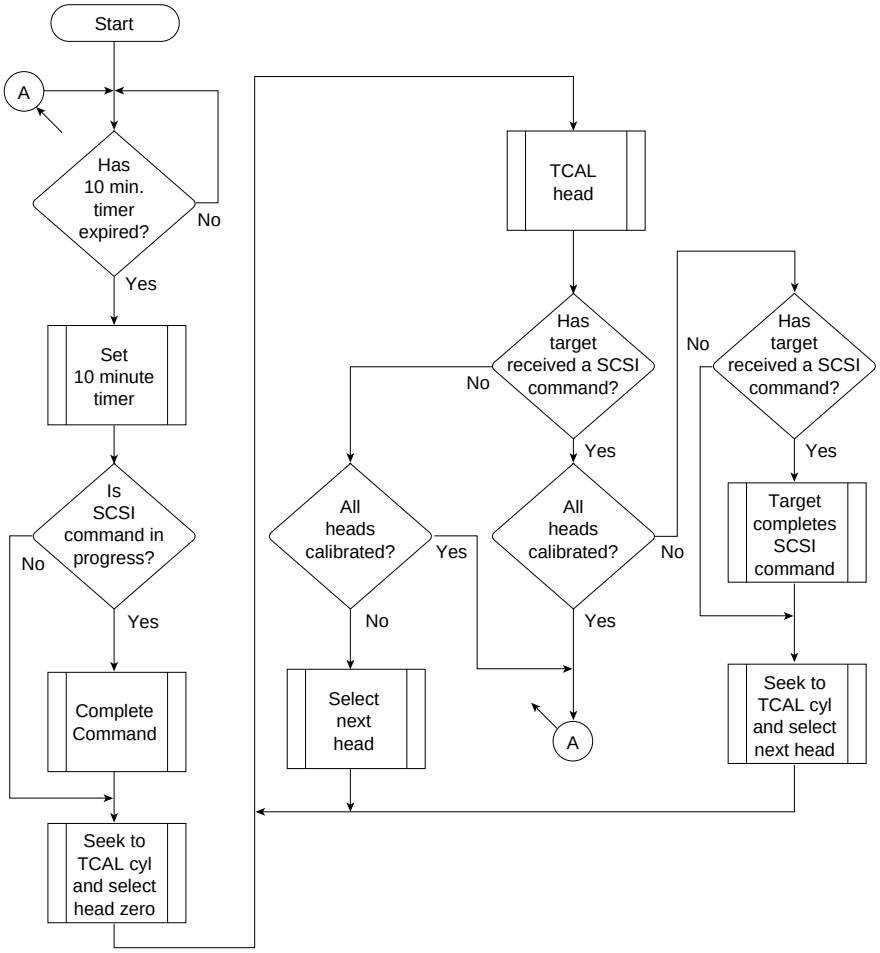


Figure 3. OEM interruptible thermal calibration implementation

5.2.1 Seek time

	Drive level (msec)		Drive including controller overhead without disconnect* (msec)	
	read	**write**	**read**	**write**
Average typ*	8.0	9.0	9.0	10.0
Single track typ*	0.6	0.9	1.6	1.9
Full stroke typ*	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)	60 minutes
Maximum (without verify)	40 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	5.30 Mbytes/sec*
Maximum	8.94 Mbytes/sec*
Data transfer rate (< 1 track)	
Minimum, divided by interleave factor	3.56 Mbytes/sec
Maximum, divided by interleave factor	7.65 Mbytes/sec
Sector sizes	
Default	512-byte data blocks
Variable in even-sector sizes	180 to 4,096 bytes
SCSI interface data	
Async. transfer rate, max instantaneous	
ST15150N/ND	5.0 Mbytes/sec*, **
ST15150W/WD/WC/DC	10.0 Mbytes/sec*, ***
Synchronous transfer rate fast	
ST15150N/ND	0.5 to 10.0 Mbytes/sec
Synchronous transfer rate wide	
ST15150W/WD/WC/DC	0.5 to 20.0 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 and no cable loss.

*** Assumes system ability to support 10.0 Mbytes/sec 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. If a recoverable error condition is detected during the start sequence, the drive executes a recovery procedure–this may cause the time it takes for the drive to become ready to exceed 30 seconds. During the start sequence, the drive responds to some commands over the SCSI interface. Stop time is less than 30 seconds after removing DC power. This means the motor starts as soon as power is applied. During this time the drive responds to some commands over the SCSI interface. Stop time is less than 30 seconds 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 an error recovery procedure, if needed). 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 that 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 954 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, if possible, 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, 954 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. Read command is received and the first logical block is already in the cache.

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

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

5.6 Caching write data

Write caching is a drive write operation that uses a drive buffer storage area where the data to be written to the disc is stored 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. 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, the data is written into the beginning of the same cache segment, overwriting the data that was written there at the beginning of the operation. However, the drive does not overwrite data that has not yet been written to the disc.

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 capacity and transfer rate in a cost-effective manner.

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

Note. ST15150WC/DC drives can use J6 pin 37 from the SCA connector or J04 pin 6 for spindle sync.

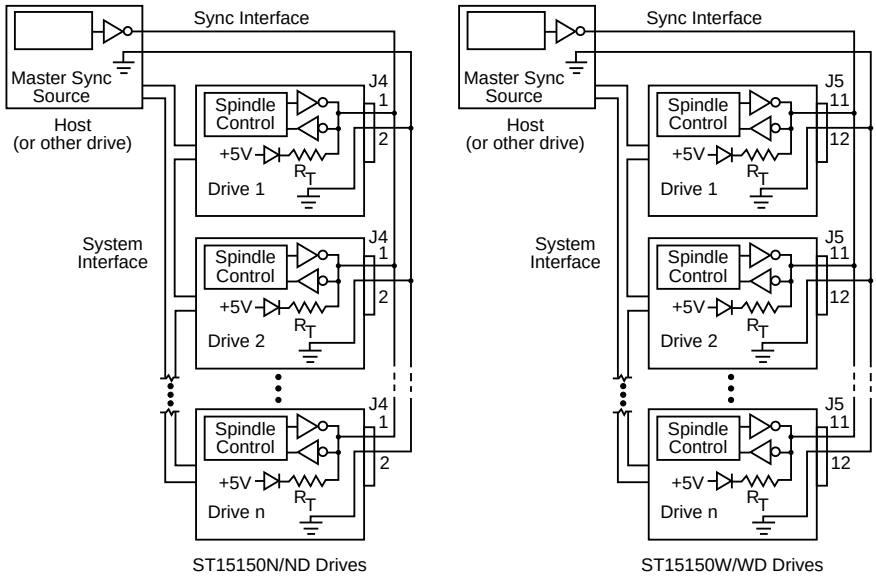


Figure 4. Synchronized drive interconnect diagram

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.

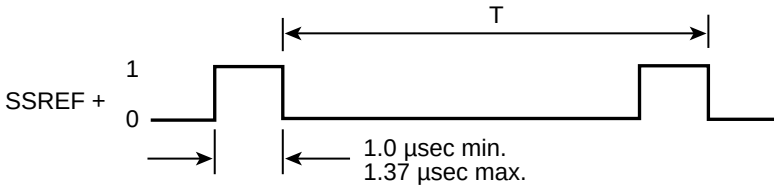
Each drive also can be configured for the non-synchronized mode in which it ignores any reference signal that might be present—this is the default mode as shipped from the factory. The connection of the synchronized reference signal to the host is required only if the host provides the reference signal. 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 Pike 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. The 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
± 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 04h is used for enabling and disabling spindle synchronization mode (see the *SCSI-2 Interface Product Manual).* When the target achieves synchronization, it sends 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 Spindles Synchronized (5C01) or Spindles 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 Spindles Synchronized (5C01) or Spindles Not Synchronized (5C02).

You may operate the drive may 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 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 translation of the digital offset values to physical rotational offsets results in offset values whose phase error lies within the $\pm$ 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 operational 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	800,000 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, “Defect and error management.”

6.1.1 Environmental interference

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

An unrecoverable error or condition is defined as one that:

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

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 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 (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 4 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 800,000 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.

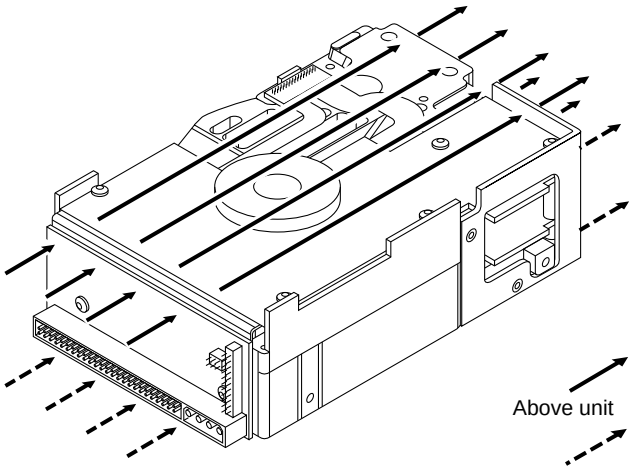
Data is calculated on a rolling-average base for a minimum period of six months.

6.2.2 Air flow

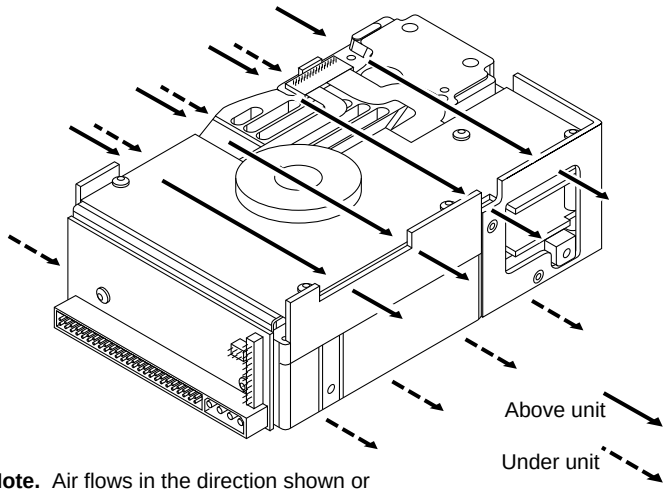
The rack, cabinet, or drawer environment for the Barracuda 4 drive must provide cooling of the electronics and head and disc assembly (HDA). You should confirm that adequate cooling is provided using the temperature measurement guidelines described below.

Orient the drive or direct the 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 4 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 (ST15150N shown)

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 and, after the temperatures stabilize, measure the case temperature of the components listed on the next several pages.

To obtain the maximum temperature for each of the reference components listed, add 15°C to the MTBF case temperatures. 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.

Air-flow cooling
ST15150N drives
single-ended

Card	Component	Reference	MTBF 800k hours case temperature (°C)
AYHX	Polar	1	48
AYHX	Writer	2	64
AYHX	CSAW	3	47
AYHX	Pike	4	52
AYHX	Driver	5	60
HDA housing		Figure 13	

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), plus a 5°C temperature rise in the test enclosure (35°C ambient local to the drive).

The maximum allowable HDA case temperature is 60°C.

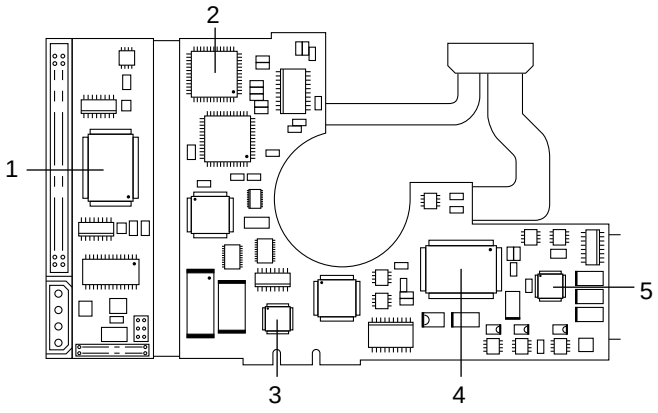


Figure 7. AYHX temperature measurement locations

Air-flow cooling
ST15150ND drives
differential

Card	Component	Reference	MTBF 800k hours case temperature (°C)
LYHX	Polar	1	48
LYHX	Writer	2	64
LYHX	CSAW	3	47
LYHX	Pike	4	52
LYHX	Driver	5	60
HDA housing		Figure 13	

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), plus a 5°C temperature rise in the test enclosure (35°C ambient local to the drive).

The maximum allowable HDA case temperature is 60°C.

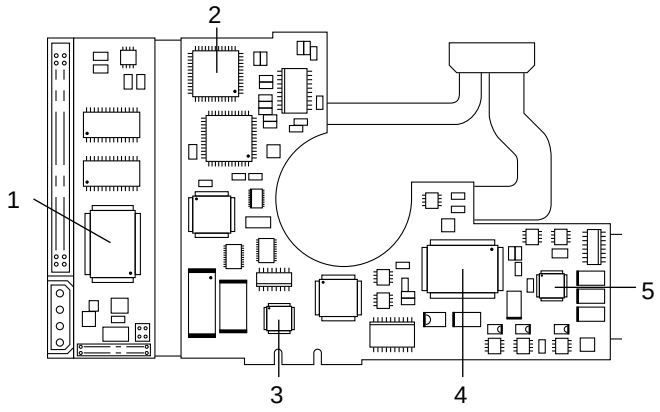


Figure 8. LYHX temperature measurement locations

Air-flow cooling
ST15150W drives
single-ended wide

Card	Component	Reference	MTBF 800k hours case temperature (°C)
MYHX	Polar	1	48
MYHX	Writer	2	64
MYHX	CSAW	3	47
MYHX	Pike	4	52
MYHX	Driver	5	60
HDA housing		Figure 13	

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), plus a 5°C temperature rise in the test enclosure (35°C ambient local to the drive).

The maximum allowable HDA case temperature is 60°C.

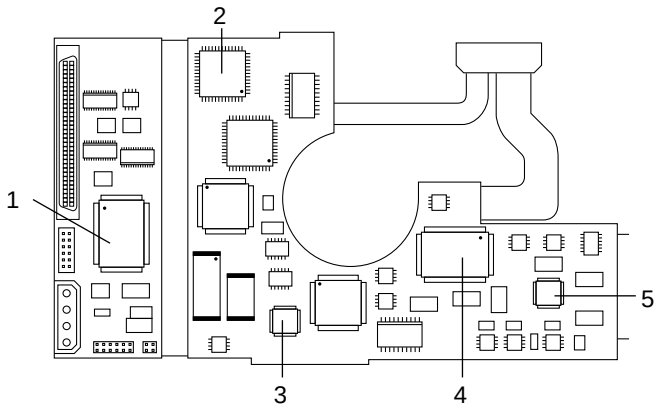


Figure 9. MYHX temperature measurement locations

Air-flow cooling
ST15150WD drives
differential wide

Card	Component	Reference	MTBF 800k hours case temperature (°C)
NYHX	Polar	1	48
NYHX	Writer	2	64
NYHX	CSAW	3	47
NYHX	Pike	4	52
NYHX	Driver	5	60
HDA housing		Figure 13	

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), plus a 5°C temperature rise in the test enclosure (35°C ambient local to the drive).

The maximum allowable HDA case temperature is 60°C.

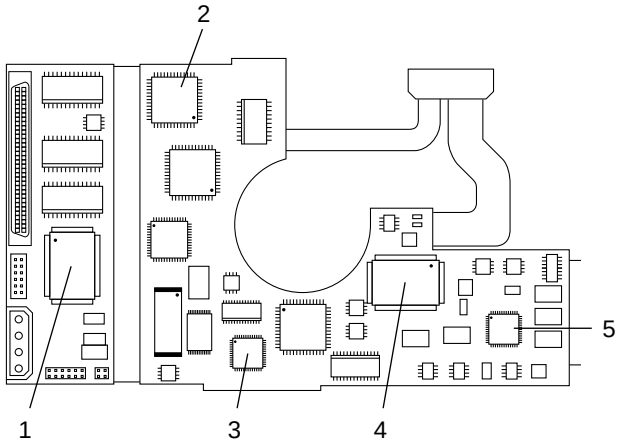


Figure 10. NYHX temperature measurement locations

Air-flow cooling
ST15150WC drives
single-ended wide (SCA)

Card	Component	Reference	MTBF 800k hours case temperature (°C)
JYHX	Polar	1	48
JYHX	Writer	2	64
JYHX	CSAW	3	47
JYHX	Pike	4	52
JYHX	Driver	5	60
HDA housing		Figure 13	

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), plus a 5°C temperature rise in the test enclosure (35°C ambient local to the drive).

The maximum allowable HDA case temperature is 60°C.

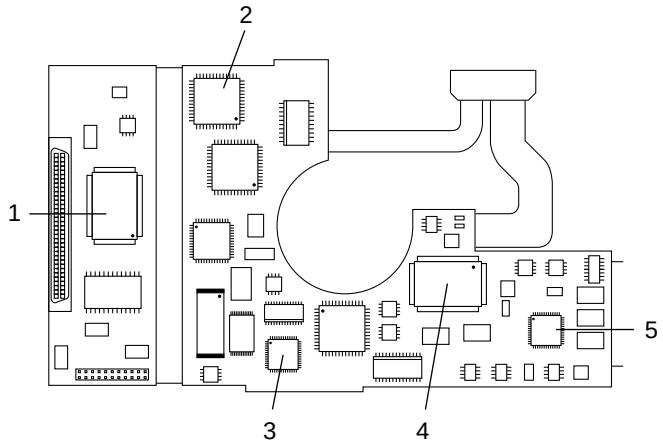


Figure 11. JYHX temperature measurement locations

Air-flow cooling
ST15150DC drives
differential wide (SCA)

Card	Component	Reference	MTBF 800k hours case temperature (°C)
KYHX	Polar	1	48
KYHX	Writer	2	64
KYHX	CSAW	3	47
KYHX	Pike	4	52
KYHX	Driver	5	60
HDA housing		Figure 13	

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), plus a 5°C temperature rise in the test enclosure (35°C ambient local to the drive).

The maximum allowable HDA case temperature is 60°C.

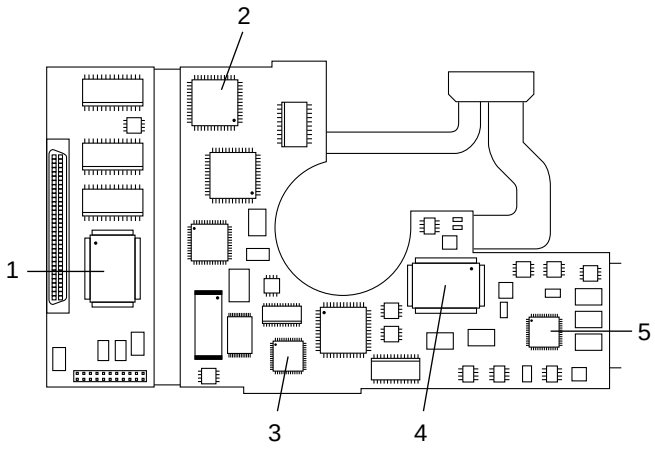


Figure 12. KYHX temperature measurement locations

Measure the HDA housing temperature at the location specified in Figure 13.

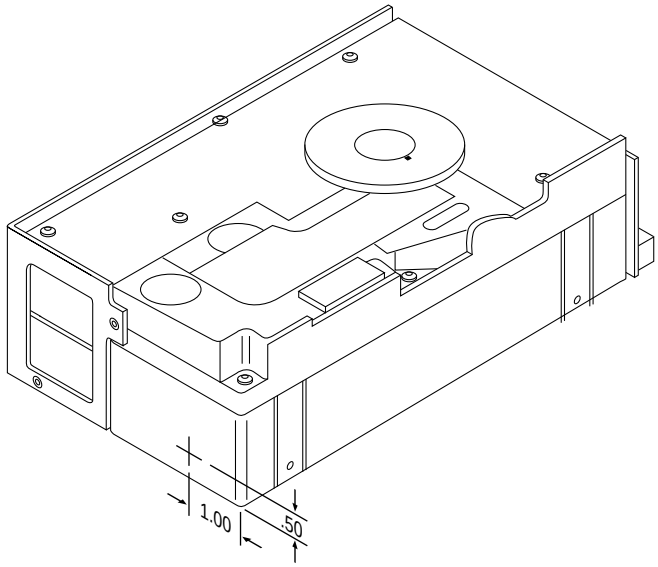


Figure 13. Temperature measurement location

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 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 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 4 Installation Guide* (83328870) 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 4 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.

Notes. It is the responsibility of the systems integrator to assure that no temperature, energy, or voltage hazard is presented during the hot connect/disconnect operation.

The SCSI bus termination must be external to the drive being inserted or removed.

Connector J01 must be configured so there is no connection between the drive and the TRMPWR signal on the SCSI bus. Removing all term power jumpers accomplishes this.

When installing the drive on a carrier or tray, discharge the static electricity from the carrier or tray prior to inserting it into the system.

Procedure:

1. Ensure that all I/O processes to the drive you are insertinng or removing have ceased (for ST15150WC and ST15150DC drives, all I/O processes on the entire SCSI bus must be inactive). All other devices on the same SCSI bus must have receivers that conform to the SCSI-3 standard.
2. When inserting a drive, attach the power connector to the drive first, at least 1 millisecond before attaching the I/O connector to the bus. Maintain the ground connections during and after connecting the drive to the SCSI bus.

   When removing a drive, disconnect the I/O connector at least 1 millisecond before removing the power connector from the drive, and wait for the spindle to stop. The disc drive motor should come to a complete stop prior to changing the plane of operation to ensure data integrity.

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

The power to the electronics and mechanics of the drive may be simultaneously switched with the bus contacts if the power distribution system is able to maintain adequate power stability to other devices during the transition and the grounding requirements are met by following the instructions provided in step 2.

7.0 Physical/electrical specifications

This section provides information relating to the physical and electrical characteristics of Barracuda 4 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 for ST15150N/ND/W/WD/WC/DC drives

		N/W/WC		ND/WD/DC	
		±5V[11]	±12V	±5V[11]	±12V
Voltage regulation [5]	**Notes**	**±5%**	**±5%[2]**	**±5%**	**±5%[2]**
Amps					
Max operating current DC 3σ	[1]	0.95	0.95	1.19	0.95
Average idle current DC $\overline{X}$	[1] [12]	0.63	0.78	0.69	0.78
Max start current					
(peak) DC 3σ	[3] [6]	0.93	2.18	1.02	2.18
(peak) AC 3σ	[3]	—	3.10	—	3.10
Delay motor start (max) DC 3σ	[1] [4]	0.95	0.10	0.94	0.10
Peak operating current					
Typical DC $\overline{X}$	[1] [10]	0.92	0.86	1.13	0.86
Maximum DC 3σ	[1]	0.95	0.95	1.19	0.95
Maximum (peak) AC 3σ		1.08	1.8	1.95	1.8
Track following at					
OD DC $\overline{X}$	[1]	0.91	0.80	0.97	0.80
ID DC $\overline{X}$	[1]	0.89	0.86	0.96	0.86
Read track					
OD DC 3σ	[1] [14]	0.97	0.89	1.39	0.89
AC 3σ		1.05	1.10	1.96	1.10
Seeking					
Typical DC $\overline{X}$	[1] [13]	0.91	1.10	0.98	1.10
Maximum DC 3σ	[1]	0.92	1.20	1.02	1.20
Maximum (peak) AC 3σ		1.05	1.87	1.7	1.87

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 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 Figure 14.

[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 is inclusive of ripple, noise, and transient response.

[6] At power-up, the motor current regulator limits the 12V current to an average value of less than 2.18A, although instantaneous peaks may exceed this value. These peaks should measure 5 msec duration or less.

[7] Minimum current loading for each supply voltage is not less than 3% of the maximum operating current shown.

[8] The +5V and +12V supplies employ separate ground returns.

No terminator power. See Section 11.7.3.4.

[9] 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.

[10] Operating condition is defined as a third stroke seek at OD and read one track. A command is issued every 0.063 sec for N/W/WD/WC/DC drives (0.075 sec for ND drives).

[11] No terminator power. See 11.7.3.4.

[12] All power saving features enabled; ASA II code only.

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

[14] Read track is defined as repeat reads of track 15 with a 60% duty cycle for N/ND drives, 74% duty cycle for W drives, 32% duty cycle for WC drives, 44% duty cycle for WD drives, and 50% duty cycle for DC drives.

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

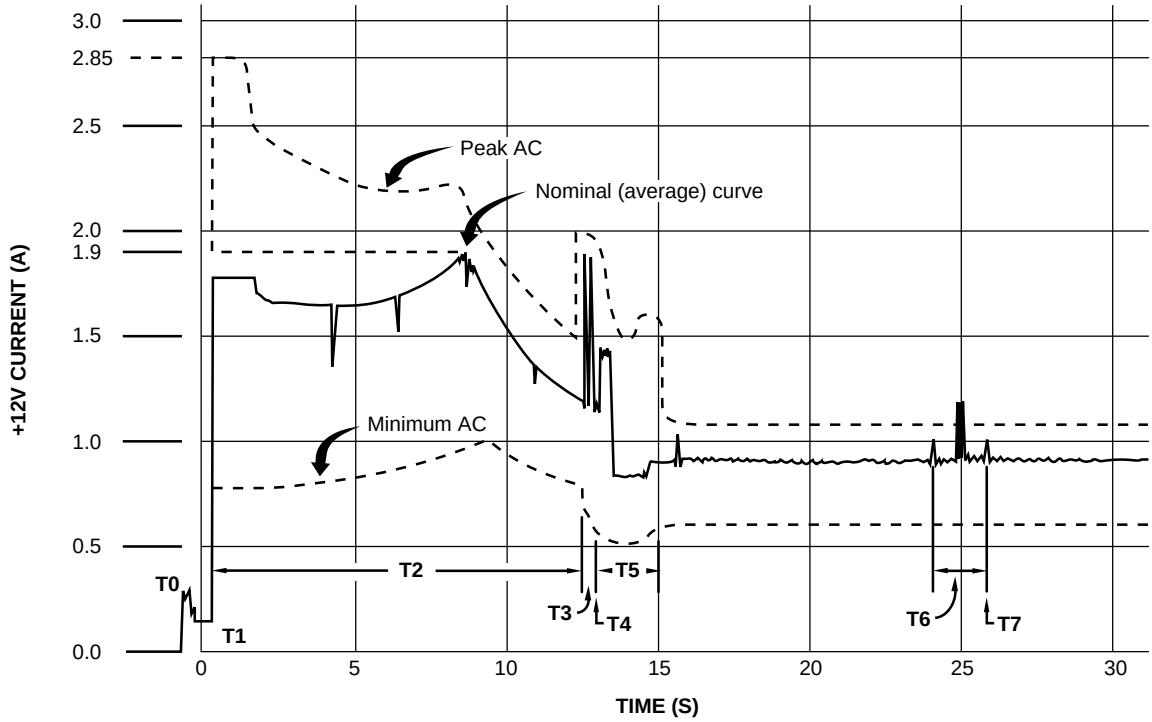


Figure 14. Typical Barracuda 4 drive +12V current profile

T0 Power is applied to the drive.

T1 Controller self-tests are performed.

T2 Spindle begins to accelerate under current limiting after performing 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.

	ST15150N/W/WC	ST15150ND/WD/DC
Typical seek and read power dissipation of DC power average at nominal voltages	15W (51 BTUs/hr)	16W (54 BTUs/hr)
Typical power dissipation under idle conditions	12W (41 BTUs/hr)	12W (41 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, 8, 9, 10, 11, and 12 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 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 18.

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. Do not apply shock 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

48 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.

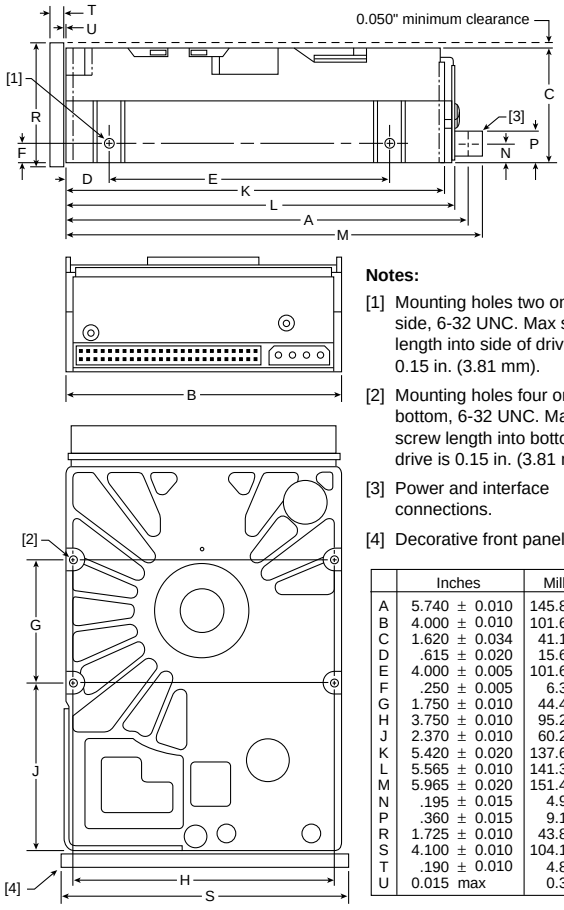
7.5 Electromagnetic compatibility

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 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 15 for detailed mounting configuration dimensions for ST15150N/ND drives. Refer to Figure 16 for detailed mounting configuration dimensions for ST15150W/WD drives. Refer to Figure 17 for detailed mounting configuration dimensions for ST15150WC/DC drives. A minimum clearance of 0.050 inches must be maintained from the PWA side of the drive.

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).

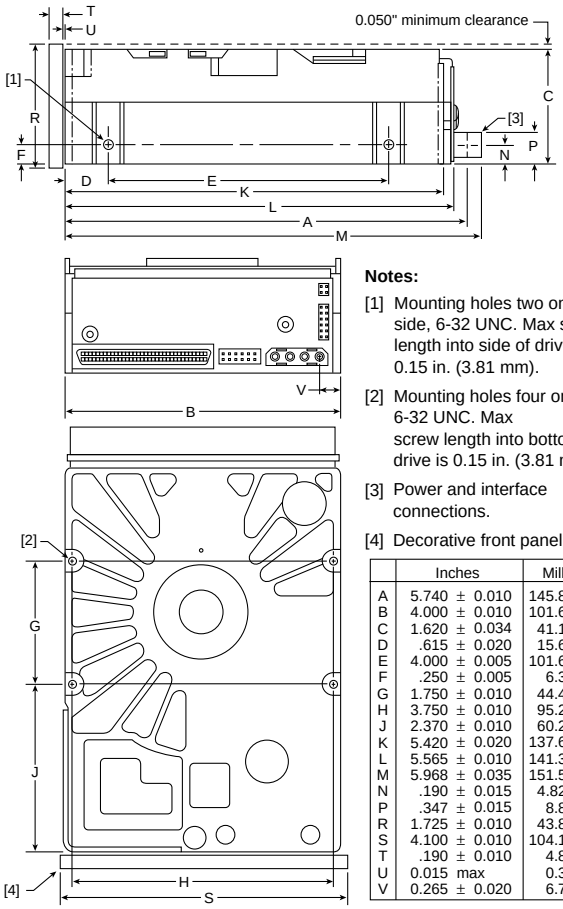
[2] Mounting holes four on bottom, 6-32 UNC. Max screw length into bottom of drive is 0.15 in. (3.81 mm).

[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	5.965 ± 0.020	151.41 ± .50
N	.195 ± 0.015	4.95 ± .38
P	.360 ± 0.015	9.14 ± .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

Figure 15. Mounting configuration dimensions for N/ND drives



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).

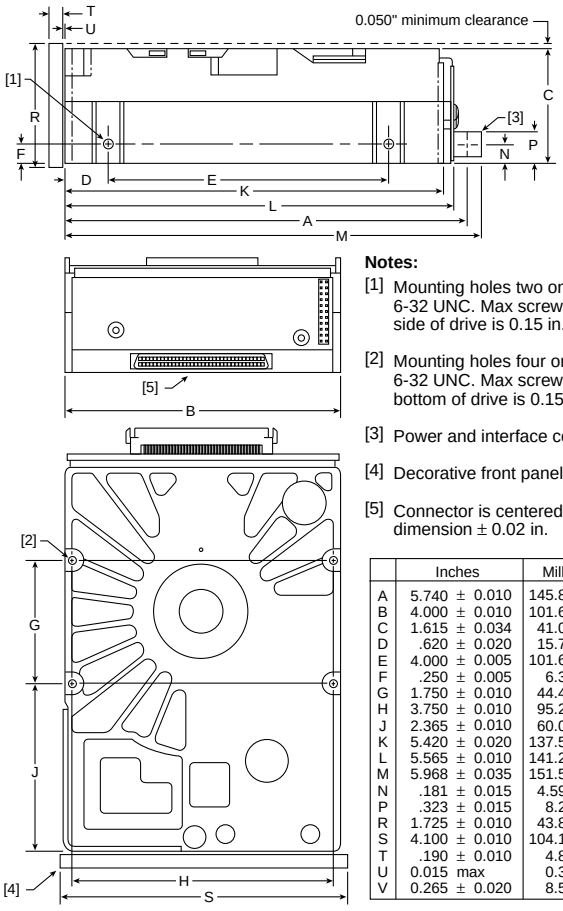
[2] Mounting holes four on bottom, 6-32 UNC. Max screw length into bottom of drive is 0.15 in. (3.81 mm).

[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	6.73 ± .50

Figure 16. Mounting configuration dimensions for W/WD drives



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 four 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.

[5] Connector is centered within “B” dimension ± 0.02 in.

	Inches	Millimeters
A	5.740 ± 0.010	145.80 ± .25
B	4.000 ± 0.010	101.60 ± .25
C	1.615 ± 0.034	41.02 ± .86
D	.620 ± 0.020	15.75 ± .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	2.365 ± 0.010	60.07 ± .25
K	5.420 ± 0.020	137.52 ± .50
L	5.565 ± 0.010	141.22 ± .25
M	5.968 ± 0.035	151.58 ± .90
N	.181 ± 0.015	4.597 ± .38
P	.323 ± 0.015	8.20 ± .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

Figure 17. Mounting configuration dimensions for WC/DC drives

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. To ensure proper performance, rigidly mount the drive to the host system in accordance with the requirements in this product manual.

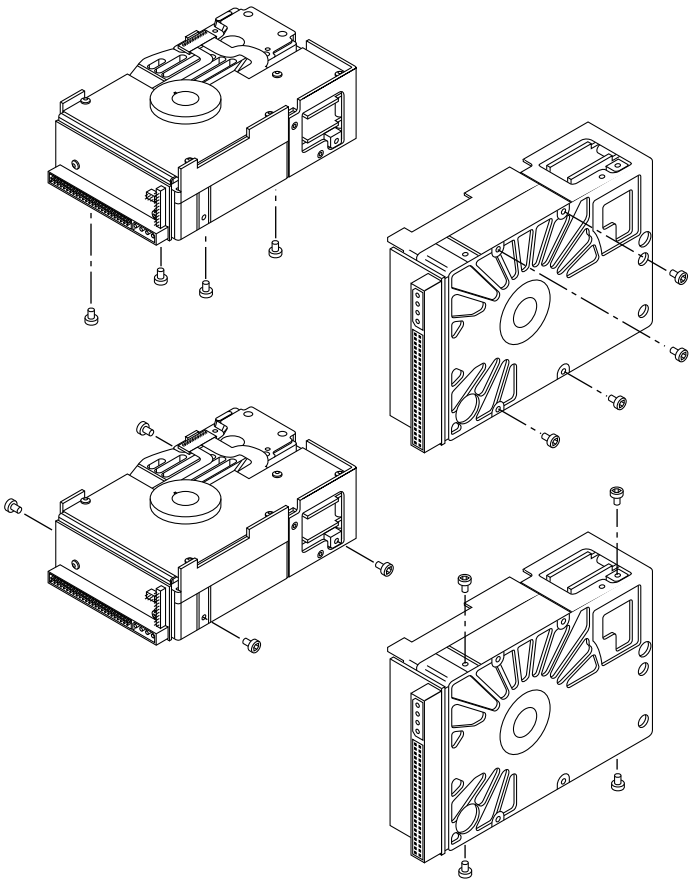


Figure 18. Recommended mounting

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 7.4.1.

8.0 Media characteristics

This section provides information regarding the media used in Barracuda 4 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 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 Drive internal defects/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 operation 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 on the drive Error Recovery philosophy is presented in Section 6 of the *SCSI-2 Interface Product Manual.*

10.0 Drive configuration

This section describes how to configure Barracuda 4 drives. Option headers may be used to customize many functions of the drives for your particular system. You can also synchronize the spindles of two or more ST15150N/ND/W/WD drives using circuit-board connectors. ST15150WC/DC drives use J4 pin 6 for synchronizing spindles.

10.1 Option headers

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

10.1.1 ST15150N/ND drives option headers

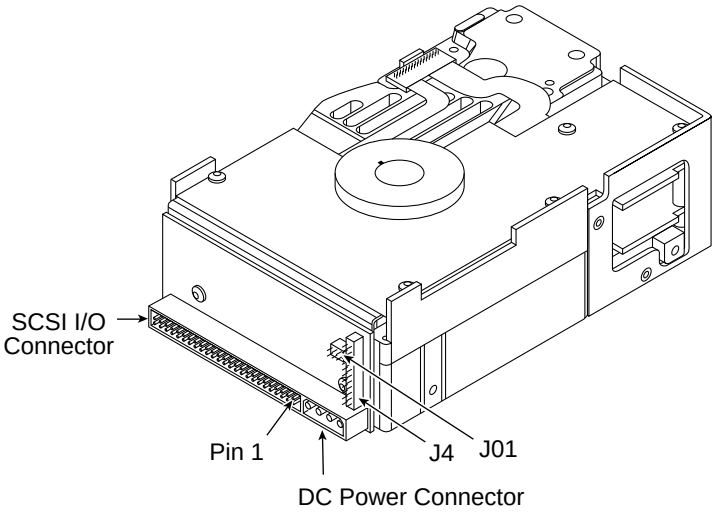


Figure 19. ST15150N/ND drives option header locations

ST15150N and ST15150W models can be terminated using option headers. ST15150ND, ST15150WD, ST15150WC, and ST15150DC models must be terminated externally. See Section 10.4.

Figure 20 illustrates ST15150N/ND drives option select jumper connectors.

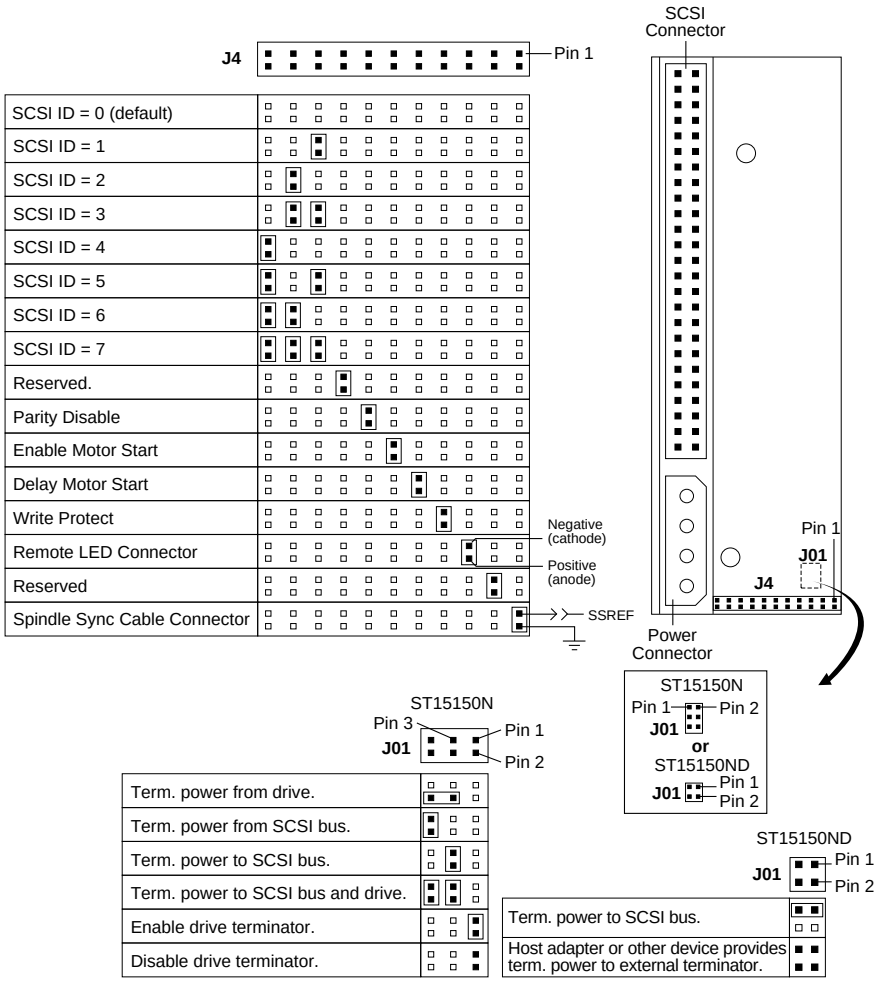


Figure 20. ST15150N/ND drives option select jumper connectors

	Block	Pins	Function
ST15150N	J01	1&2	Terminator enable.
J01 option jumpers		3&4	Terminator power to the SCSI bus.
		5&6	Terminator power from the SCSI bus.
		3&4 and 5&6	Terminator power to the SCSI bus and drive.
		4&6	Terminator power from the drive.
ST15150ND	J01	1&3	Terminator power to the SCSI bus.
J01 option jumpers		—	Host adapter or other device on the SCSI bus provides terminator power to the external terminator (no jumper on any of the J01 pins).
ST15150N/ND	J4	1&2	Spindle sync cable connector.
J4 option jumpers			Pin 1 is the SSREF+ or reference index signal.
			Pin 2 is Gnd.
		3&4	Reserved. Default is no jumper.
		5&6	Remote LED connector. Pin 5 is cathode (neg). Pin 6 is anode (pos). Pin 6 is current limited through a 1K ohm, 1/10W resistor.
		7&8	Write Protect option. Jumper installed write protects the entire disc drive. Default is no jumper.
		9 & 10	Delay Motor Start option. Jumper installed waits for 10 seconds for each target ID number before starting the spindle motor automatically. Default is no jumper.
			Example: If target ID is equal to three (3) 3 x 10 = 30 Target spindle motor starts in thirty (30) seconds.
		11&12	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.
		13&14	Parity Disable option. Jumper installed causes parity checking and error reporting to be disabled. Default is no jumper.
		15&16	Reserved. Default is no jumper.
		17&18*	SCSI ID selector 0
		19&20*	SCSI ID selector 1
		21&22*	SCSI ID selector 2

* See Figure 20 to set the SCSI ID on ST15150N/ND drives

10.1.2 ST15150W/WD drives option headers

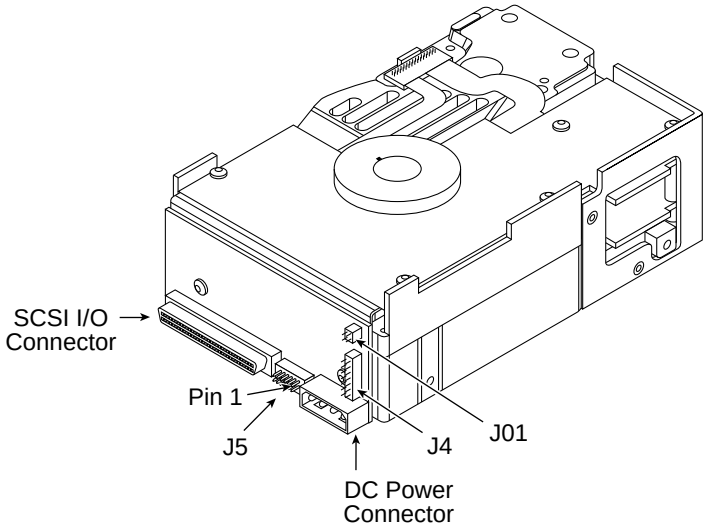


Figure 21. ST15150W/WD drives option header locations

Figure 22 illustrates ST15150W/WD drives option select jumper connectors.

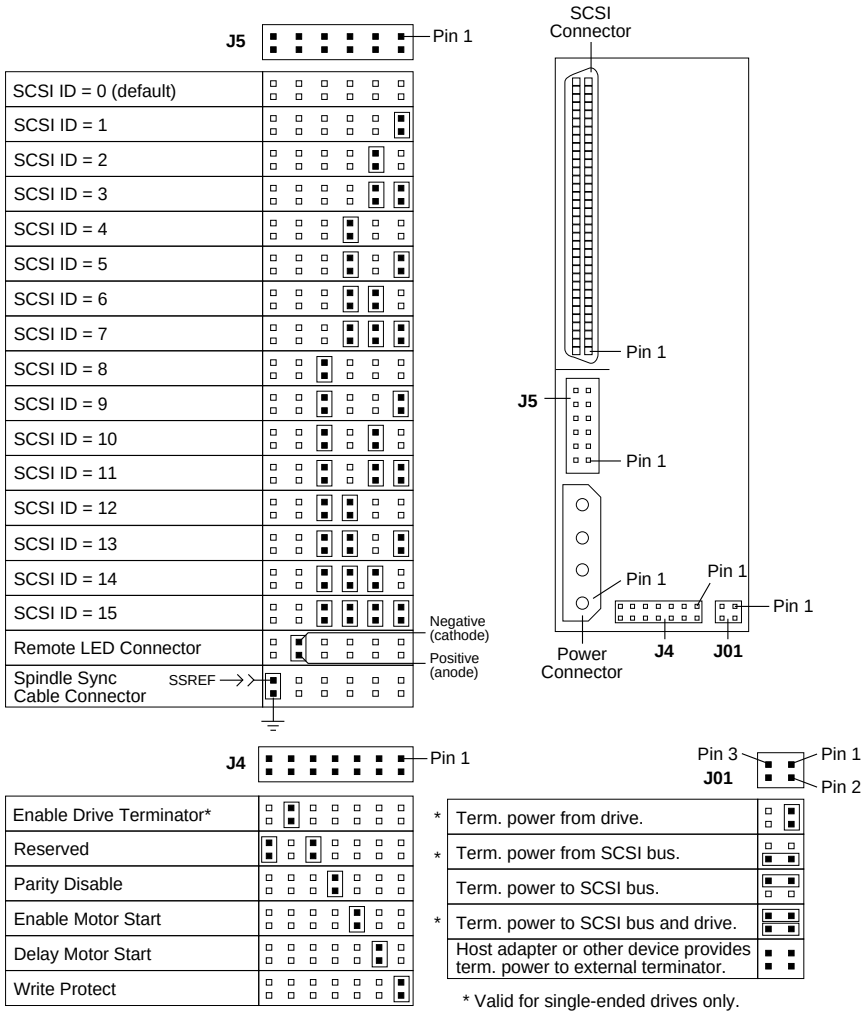


Figure 22. ST15150W/WD drives option select jumper connectors

Block	Pins	Function
J01	1&2*	Terminator power supplied from 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.
	—	Host adapter or other device on the SCSI bus provides terminator power to the external terminator (no jumper on any of the J01 pins).
J4	1&2	Write Protect option. Jumper installed write protects the entire disc drive. Default is no jumper.
	3&4	Delay Motor Start option. Jumper installed waits for 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 three (3) $(3 \times 10) + 3 = 33$ Target spindle motor starts in 33 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 ST15150W Drive Terminator. Jumper installed enables the drive terminator on ST15150W drives. Jumper removed disables the drive terminator. Default is no jumper.
	13&14	Reserved. Default is no jumper.
J5	1&2**	SCSI ID selector 0
	3&4**	SCSI ID selector 1
	5&6**	SCSI ID selector 2
	7&8**	SCSI ID selector 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 Ground.

* Valid for single-ended (ST15150W) drives only.
** See Figure 22 to set the SCSI ID.

10.1.3 ST15150WC/DC drives option headers

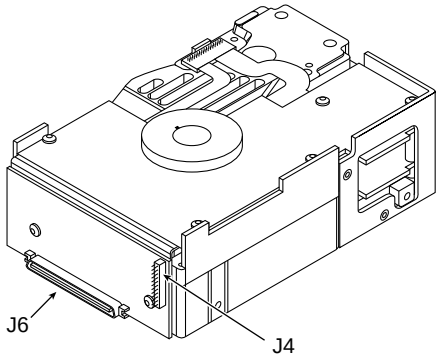


Figure 23. ST15150WC/DC drives option header locations

Figure 24 illustrates ST15150WC/DC drives option select jumper connectors.

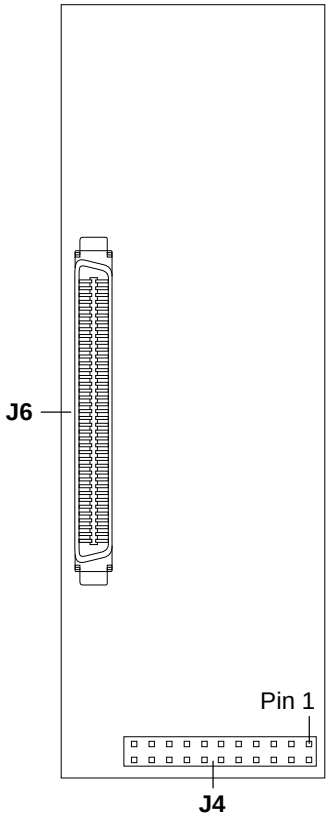


Figure 24. ST15150WC/DC drives option select connectors

Block	Pin	Function
J04	1	ID0
	2	Fault
	3	ID1
	4	Vendor unique
	5	ID2
	6	Spindle sync
	7	ID3
	8	Activity LED
	9	No connection
	10	+5V
	11	Reserved
	12	Reserved
	13	Reserved
	14	Reserved
	15	Ground
	16	Write protect
	17	Reserved
	18	Reserved
	19	Parity enable
	20	Ground
	21	Reserved
	22	Reserved

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. The system operation is described in Section 5.7.

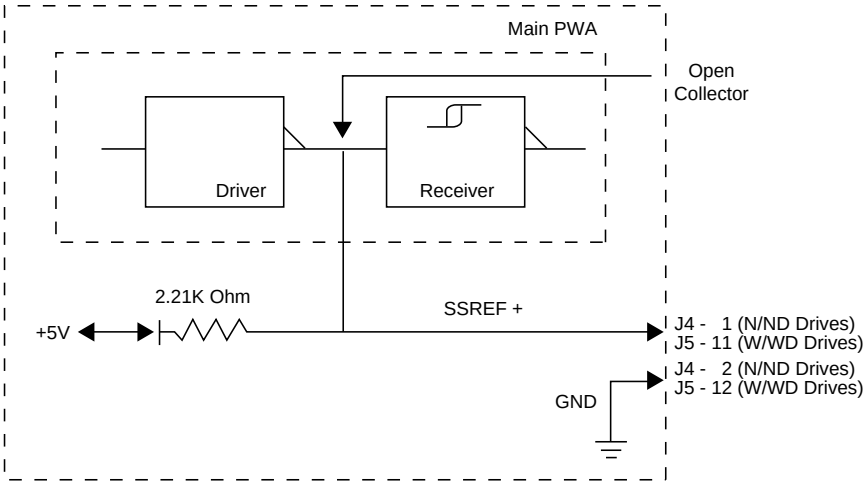
10.2.1 Electrical description

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 25 shows a diagram of the driver/receiver circuit. 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



ST15150WC/DC drives use J04 pin 6 for synchronizing spindles.

Figure 25. 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. A diode prevents current from backfeeding.

10.2.1.3 Physical interface

Dimensions of the J04 (J4) connector mounted on the main PCB of ST15150N/ND drives to interconnect the drives are shown in Figure 26. The connector is a 22-pin, 11-position gold 2 mm header type. Only pins 1 and 2 are used for connecting the reference index signal cable, as shown in Figure 20. Pin 1 is SSREF+ and pin 2 is ground.

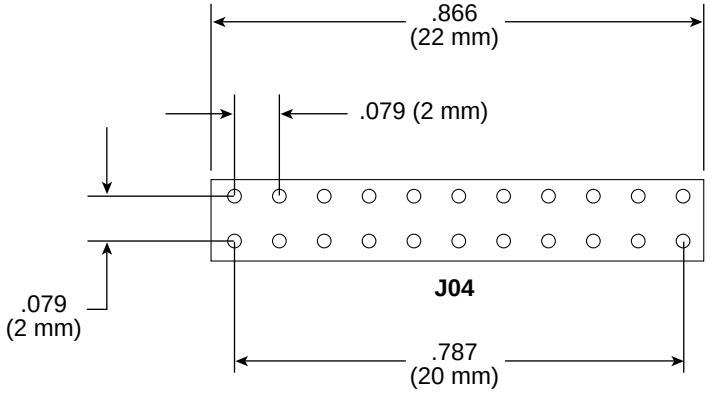


Figure 26. ST15150N/ND drives configuration select header specification

Dimensions of the J5 connector mounted on the main PCB of ST15150W/WD drives to interconnect the drives are shown in Figure 27. The connector 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 22. Pin 11 is SSREF+ and pin 12 is ground.

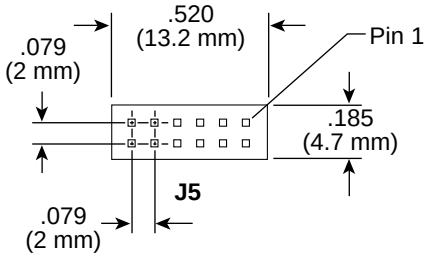


Figure 27. ST15150W/WD drives configuration select header specification

10.3 Grounding

Signal ground (PCB) and HDA ground are connected together in the Barracuda 4 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.

10.4 Drive termination

ST15150N
To enable internal drive termination, install a jumper on J01 pins 1 and 2 as shown in Figure 20.

ST15150ND
You must provide external drive termination when termination is required.

ST15150W
To enable internal drive termination, install a jumper on J4 pins 11 and 12 as shown in Figure 22.

ST15150WD
You must provide external drive termination when termination is required.

ST15150WC
You must provide external drive termination when termination is required.

ST15150DC
You must provide external drive termination when termination is required.

11.0 Interface requirements

This section describes the interface requirements as implemented on Barracuda 4 drives.

ASA I is Seagate's first generation of Advanced SCSI Architecture firmware. ASA II is Seagate's second generation of Advanced SCSI Architecture firmware.

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 4 lists the messages supported by the Barracuda 4 drives SCSI-1 and SCSI-2 modes.

Table 4. SCSI messages supported

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

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

11.3 SCSI interface commands supported

Table 5 lists the SCSI interface commands supported in SCSI-1 and SCSI-2 modes. Barracuda 4 family drives can be changed back and forth between SCSI-1 and SCSI-2 modes by using the Change Definition command. Standard OEM drives are shipped set to operate in SCSI-2 mode.

Table 5. Supported commands

		Supported by		
Command name	**Command code**	**ASA I SCSI-1**	**ASA I SCSI-2**	**ASA II SCSI-2**
Change Definition	40h	Y	Y	Y
Compare	39h	N	N	N
Copy	18h	N	N	N
Copy and Verify	3Ah	N	N	N
Format Unit [1]	04h	Y	Y	Y
Inquiry	12h	Y	Y	Y
Date Code Page		N	Y	Y
Firmware Numbers Page		N	Y	Y
Implemented Operating Def. Page		N	Y	Y
Jumper Settings Page		N	Y	Y
Unit Serial Number Page		N	Y	Y
Vital Product Data Page		N	Y	Y
Lock-Unlock-Cache	36h	N	N	N
Log Select	4Ch	N	Y	Y
Log Sense	4Dh	N	Y	Y
Mode Select (6) (Same pages as Mode Sense)	15h	Y	Y	Y
Mode Select (10)	55h	N	Y	Y
Mode Sense (6)	1Ah	Y	Y	Y
Caching Parameters Page (08h)		N	Y	Y
Control Mode Page (0Ah)		N	Y	Y
Disconnect/Reconnect Control (02h)		Y	Y	Y
Error Recovery Page (01h)		Y	Y	Y
Format Page (03h)		Y	Y	Y
Notch and Partition Page (0C) (media zones)		N	Y	Y
Power Condition Page (0C)		N	N	Y
Rigid Disc Drive Geometry Page (04h)		Y	Y	Y
Unit Attention Page (00h)		Y	Y	Y
Verify Error Recovery Page (07h)		N	Y	Y
Mode Sense (10)	5Ah	N	Y	Y
Not used	42-4Bh	N	N	N
Not used	4E-54	N	N	N
Not used	58-59	N	N	N
Not used	5B-5F	N	N	N
Not used	60-BFh	N	N	N
Not used	C0-DFh	N	N	N
Prefetch	34h	N	N	N

Command name	Command code	Supported by ASA I SCSI-1	ASA I SCSI-2	ASA II SCSI-2
Read	08h	Y	Y	Y
Read Buffer	3Ch	Y	Y	Y
Read Capacity	25h	Y	Y	Y
Read Defect Data	37h	Y	Y	Y
Read Extended	28h	Y	Y	Y
Read Long	3Eh	Y	Y	Y
Reassign Blocks	07h	Y	Y	Y
Receive Diagnostic Results	1Ch	Y	Y	Y
Supported Diagnostics Pages		Y	Y	Y
Translate Page		Y	–	–
Release	17h	Y	Y	Y
Release (10)	57h	N	Y	Y
Request Sense	03h	Y	Y	Y
Actual Retry Count Bytes		N	N	N
Extended Sense		Y	Y	Y
Field Pointer Bytes		Y	Y	Y
Reserve	16h	Y	Y	Y
Extent Reservation		N	N	N
Third Party Reserve		Y	Y	Y
Reserved (10)	56h	N	Y	Y
Rezero Unit	01h	Y	Y	Y
Search Data Equal	31h	N	N	N
Search Data High	30h	N	N	N
Search Data Low	32h	N	N	N
Seek	0Bh	Y	Y	Y
Seek Extended	2Bh	Y	Y	Y
Send Diagnostics Page	1Dh	Y	Y	Y
Supported Diagnostics Pages		Y	Y	Y
Translate Page		Y	Y	Y
Set Limits	33h	N	N	N
Start Unit/Stop Unit	1Bh	Y	Y	Y
Synchronize Cache	35h	N	Y	Y
Test Unit Ready	00h	Y	Y	Y
Verify	2Fh	Y	Y	Y
Write	0Ah	Y	Y	Y
Write and Verify	2Eh	Y	Y	Y
Write Buffer	3Bh	Y	Y	Y
Firmware download option [2]		Y	Y	Y
Write Extended	2Ah	Y	Y	Y
Write Long	3Fh	Y	Y	Y
Write Same	41h	N	Y	Y

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

[2] **Warning.** A 9 SCSI Reset or power loss during flash programming can result in firmware corruption. This usually makes the drive inoperable.

11.3.1 Inquiry data

Tables 6 and 7 list the Inquiry command data that the drive should return to the initiator per the format provided in the *SCSI-2 Interface Product Manual.*

Table 6. Barracuda 4 drives inquiry data (ASA I)

Bytes	Data (hex)															
0-15	00	00	**	***	8F	00	00	[1A]	53	45	41	47	41	54	45	20	Vendor ID
16-31	53	54	[31	35	31	35	30	4E]	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*	36*	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#													

Table 7. Barracuda 4 drives inquiry data (ASA II)

Bytes	Data (hex)															
0-15	00	00	**	***	8F	00	00	[1E]	53	45	41	47	41	54	45	20	Vendor ID
16-31	53	54	[31	35	31	35	30	4E]	20	20	20	20	20	20	20	20	Product ID
32-47	30	30	30	32	S#	S#	S#	S#	S#	S#	S#	S#	00	00	00	00	
48-63	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
64-79	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
80-95	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	
96-111	00	43	6F	70	79	72	69	67	68	74	20	28	63	29	20	31*	*Copyright
112-127	39*	39*	36*	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	41	53	41	32													ASA II

* 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.

[ ] Byte 7 is 1A for ST15150N/ND drives and 3A for ST15150W/WD drives.

[ ] Bytes 18 through 23 reflect the model of the drive (ST15150N/ND shown).
Codes for ST15150W/WD drives would be 31,35,31,35,30,57.

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 8. Mode sense data, Barracuda 4 drives default values (ASA I, 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	64	00	10	08																				
	00	7F	FE	DB	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	15	00	09	00	00	00	15	00	6C	02	00	00	01	00	0A	00	16	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	0E	80	15	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	A0	FF	00	00	00	00	00	00				
DEF																								
00	80	02	00	00																				
CHG																								
00	80	02	77	00																				

Table 9. Mode sense data, Barracuda 4 drives default values (ASA I, 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	7F	FE	DB	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	15	00	09	00	00	00	15	00	6C	02	00	00	01	00	0A	00	16	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	0E	80	15	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	1D	00	00	00	00	00	00	00	0E	7F	14	00	00	00	00	00	00	10	00
CHG																								
0C	8C	16	40	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	77	00																				

Table 10. Mode sense data, Barracuda 4 drives default values (ASA II, 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	AB	00	10	08																				
	00	7F	FE	DB	00	00	02	00																
	<——————————Mode page headers and parameter data bytes——————————>																							
Mode Page																								
DEF	81	0A	04	21	30	00	00	00	03	00	FF	FF												
CHG	81	0A	EF	FF	00	00	00	00	FF	00	00	00												
DEF	82	0E	80	80	00	0A	00	00	00	00	00	00	00	00	00	00								
CHG	82	0E	FF	FF	00	00	00	00	00	00	00	00	87	00	00	00								
DEF	83	16	00	15	00	09	00	00	00	15	00	6C	02	00	00	01	00	09	00	10	40	00	00	00
CHG	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	84	16	00	0E	80	15	00	00	00	00	00	00	00	00	00	00	00	00	00	00	1C	20	00	00
CHG	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	87	0A	00	21	30	00	00	00	00	00	FF	FF												
CHG	87	0A	0F	FF	00	00	00	00	00	00	00	00												
DEF	88	12	10	00	FF	FF	00	00	03	3A	03	96	80	02	00	00	00	00	00	00				
CHG	88	12	BD	00	00	00	FF	FF	FF	FF	00	00	A0	FF	00	00	00	00	00	00				
DEF	8A	0A	02	10	00	00	00	00	00	00	00	00												
CHG	8A	0A	03	F1	00	00	00	00	00	00	00	00												
DEF	8C	16	80	00	00	1D	00	00	00	00	00	00	00	0E	7F	14	00	00	00	00	00	00	10	00
CHG	8C	16	40	00	00	00	FF	FF	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
DEF	8D	0A	00	02	00	00	00	00	00	00	00	00												
CHG	8D	0A	00	02	00	00	00	00	00	00	00	00												
DEF	80	02	00	00																				
CHG	80	02	77	80																				
Read capacity data:																								
	7F	FE	DA	00	00	02	00																	

11.4 SCSI bus conditions and miscellaneous features supported

Asynchronous SCSI bus conditions supported by the drive are listed in Table 11. 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 11. SCSI bus conditions and other miscellaneous features

	Supported by		
Conditions or feature	**ASA I SCSI-1**	**ASA I SCSI-2**	**ASA II SCSI-2**
Adaptive caching	N	N	N
Arbitrating system	Y	Y	Y
Asynchronous data transfer	Y	Y	Y
Asynchronous event notification	N	N	N
Attention condition	Y	Y	Y
Contingent allegiance condition	N	Y	Y
Deferred error handling	N	Y	Y
Differential interface circuits available	Y	Y	Y
Disconnect/reconnect	Y	Y	Y
Parameter rounding (controlled by round bit in Mode Select page 0)	Y	Y	Y
Queue tagging (up to 64 queue tags supported)	N	Y	Y
Reporting actual retry count in extended sense bytes 15,16, and 17	N	Y	Y
Reset condition	Y	Y	Y
Segmented caching	Y	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).	Y	Y	Y
Synchronized (locked) spindle operation	Y	Y	Y
Synchronous data transfer	Y	Y	Y
Zero latency read	N	N	N

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

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 12 lists synchronous data transfer periods supported by the drive. The data transfer periods used by the drive and initiator is established by an exchange of messages during the Message phase of operation. Refer to the message protocol section in the *SCSI-2 Interface Product Manual*.

Table 12. 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	4.0
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

ST15150N/ND/W/WD drives receive DC power through a 4-pin connector mounted at the rear of the main PCB (see Figure 28, 29, or 30). Recommended part numbers of the mating connector are listed below, but equivalent parts may be used.

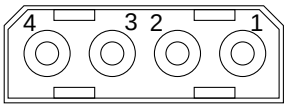
ST15150WC/DC drives receive DC power through the SCA connector (see Tables 18 and 19).

Table 13. 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 28 shows the locations of the physical interface components for the N and ND drives. Figure 29 shows the locations of the physical interface components for the W and WD drives. Figure 30 shows the locations of the physical interface components for the WC and DC drives.

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

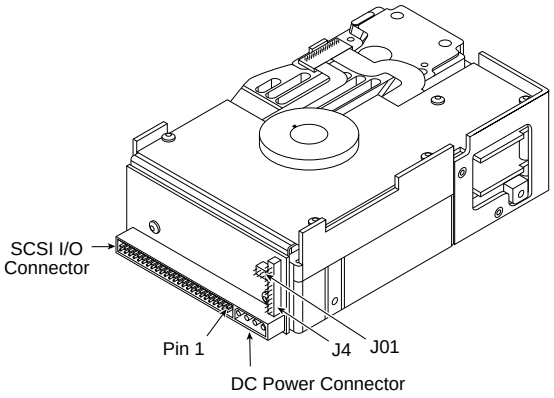


Figure 28. ST15150N/ND drives physical interface

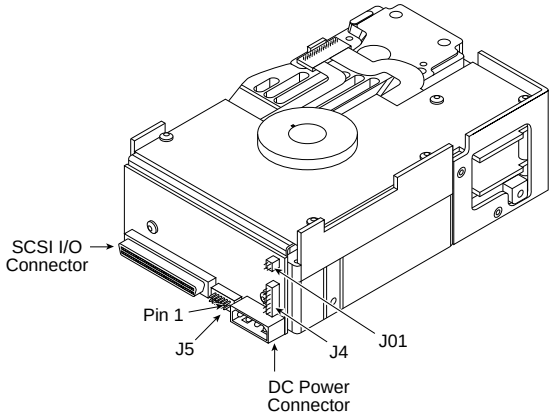


Figure 29. ST15150W/WD drives physical interface

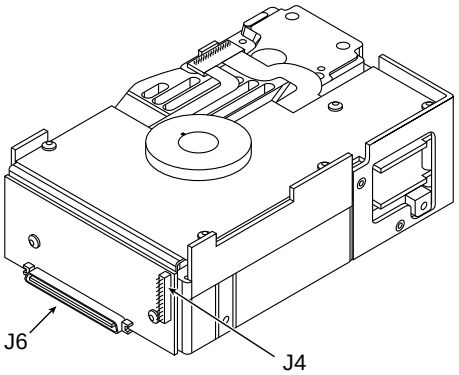


Figure 30. ST15150WC/DC drives physical interface

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 types 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 8 SCSI devices (including the host) may be daisy chained together on non-wide systems (ST15150N/ND). Wide SCSI systems (ST15150W/WD/WC/DC) can have a maximum of 16 SCSI devices (including the host) daisy chained together.

Terminate both ends of the daisy chain, but do not terminate any intermediate SCSI device. Refer to Section 11.7.3.3 for information about how to terminate each model.

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 4 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 foot) 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 ST15150N drives are shown in Table 14. Single-ended I/O cable pin assignments for ST15150W drives are shown in Table 16. Single-ended I/O cable pin assignments for ST15150WC drives are shown in Table 18.

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 pin assignments for ST15150ND drives are shown in Table 15. Differential I/O pin assignments for ST15150WD drives are shown in Table 17. Differential I/O pin assignments for ST15150DC drives are shown in Table 19.

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 somewhat lower are satisfactory. A characteristic impedance of 100 ohm +10% is recommended for non-shielded flat or twisted-pair ribbon cable. However, most available cables have a somewhat lower characteristic impedance. 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 non-shielded 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.

Only non-shielded cable connectors are applicable for N and ND drives. A 50-conductor flat cable or 25 twisted-pair cable is used. A minimum conductor size of 28 AWG should be used to minimize noise effects. Suggested non-shielded flat cable part numbers are:

Flat cable, 35M-3365-50
Twisted pair, Spectra Twist in flat 455-248-50

Equivalent parts may be used.

11.7.2 Connector requirements

ST15150N/ND drives
The non-shielded cable connector is a 50-conductor connector consisting of two rows of 25 female contacts with adjacent contents 100 mils apart.

Recommended mating flat cable connectors part numbers:

Closed end (for cable ends)	3M-3425-7000 without strain relief, no center key 3M-3425-7050 with strain relief, no center key Berg-66900-290 with strain relief, with center key
Open end (in daisy chain)	3M-3425-6000 without strain relief, no center key 3M-3425-6050 with strain relief, no center key Berg-66900-250 with strain relief, with center key

The drive device connector is a non-shielded 50-conductor connector consisting of two rows of 25 male pins with adjacent pins 100 mils apart. The connector is keyed (see Figure 33).

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

ST15150W/WD drives
Recommended mating wide cable connectors part numbers:

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

ST15150WC/DC drives
Recommended mating SCA-2 part numbers:

AMP vertical (SCA), 80-position:
787311-1, 3.18 mm tail length with polarization feature
787311-2, 3.18 mm tail length without polarization feature
787311-3, 4.57 mm tail length with polarization feature
787311-4, 4.57 mm tail length without polarization feature

11.7.3 Electrical description

ST15150N and ST15150W drives 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. These models can be configured to provide the SCSI termination.

ST15150ND and ST15150WD 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.

ST15150WC/DC drives use the single connection attachment (SCA) connector. This 80-pin connector plugs directly into a rack panel in the host system. No external cables are required. Active termination on the back panel must be provided. This connector is not recommended where cabling is required.

11.7.3.1 Single-ended drivers/receivers

Typical single-ended driver and receiver circuits for the Barracuda 4 family are shown in Figure 31. Terminator circuits shown are needed only when the disc drive is first or last on the daisy chain. (See Note 1 following Figure 31.)

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.

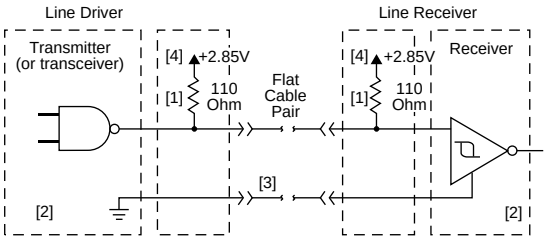


Figure 31. Single-ended transmitters and receivers

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 the length 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 ST15150WD drives are shown in Figure 32. 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's SCSI connector:

Input current on either input

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

This requirement is met with the input voltage varying between –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.

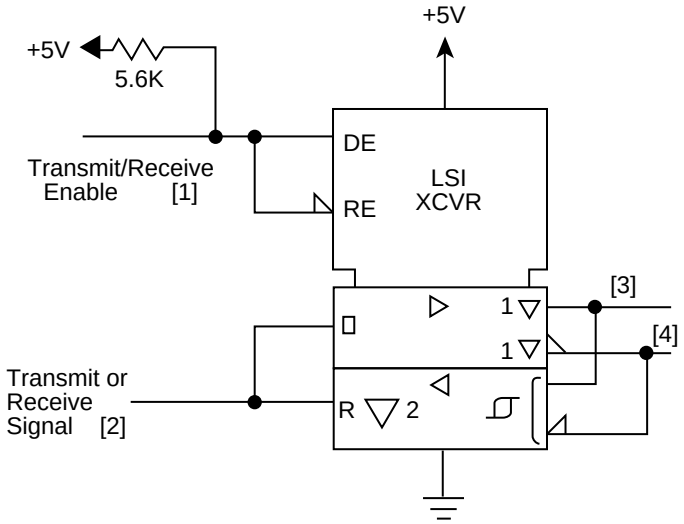


Figure 32. Typical differential I/O line transmitter/receiver and terminators

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] Terminators must be provided by user where needed.

11.7.3.3 Terminator requirements

ST15150N drives
Internal disc drive I/O termination consists of active 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.

Note. Remove the Enable Drive Terminator jumper on J01 pins 1 and 2 when terminators are not required. Removing the terminator power source jumper does not disconnect the terminator resistors from the circuit.

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.

ST15150ND/WD/DC drives
Differential I/O Barracuda drives do not have provisions to add terminator sockets on the PCB. You must provide external termination.

ST15150W drives
Internal disc drive I/O termination consists of active 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.

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. Removing the terminator power source jumper does not disconnect the terminator resistors from the circuit.

ST15150WC drives
This model does not have provisions to add terminators on the PCB. You must provide external termination.

11.7.3.4 Terminator power

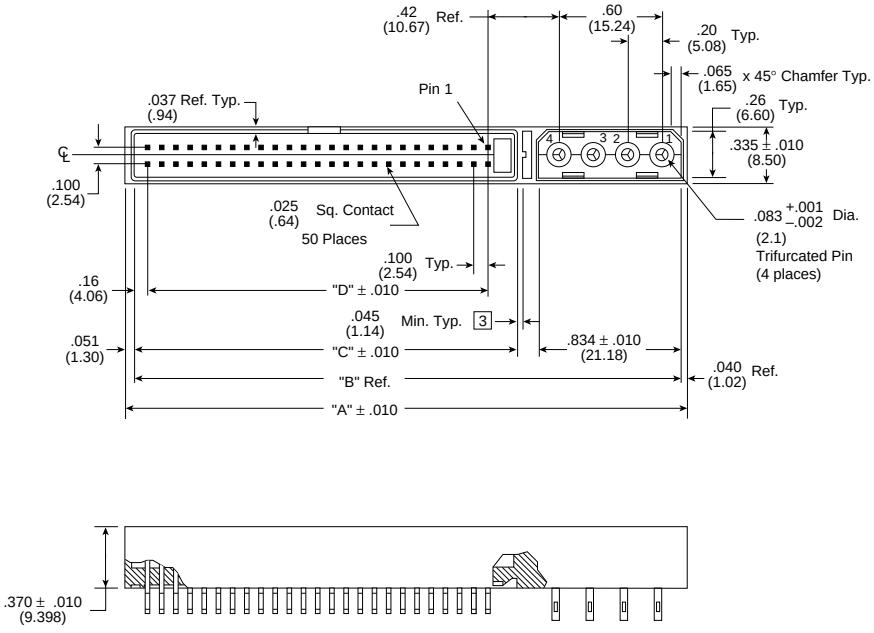
ST15150N/ND drives may be configured to accept terminator power using pin 26 of the SCSI bus, to supply power to the SCSI bus, or to provide terminator power for optional internal terminating resistors using the drive's power connector (see Figure 20). ST15150W/WD drives may be configured as stated above but using pins 17, 18, 51, and 52 (see Figure 22). 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

ST15150WC drives do not have internal termination available. You must add single-ended external termination when termination is required.

11.8 SCSI non-wide physical interface



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

Figure 33. Non-shielded SCSI device connector

Table 14. Single-ended cable pin assignments (non-shielded connector) for ST15150N drives

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

Notes:

1. All odd pins except pin 25 are connected to ground. Pin 25 is left open.

   Caution. Pin 25 must not be connected to ground at the host end or the drive end of the cable. If you accidentally plug the I/O connector in upside down, terminator power on pin 26 will be shorted to ground.

2. The minus sign preceding a signal name indicates that signal is active low.

Table 15. Differential cable pin assignments (non-shielded connector) for ST15150ND drives

+Signal name*	Pin number		–Signal name*
SHIELD GND	1	2	GROUND
DB (0)	3	4	–DB (0)
DB (1)	5	6	–DB (1)
DB (2)	7	8	–DB (2)
DB (3)	9	10	–DB (3)
DB (4)	11	12	–DB (4)
DB (5)	13	14	–DB (5)
DB (6)	15	16	–DB (6)
DB (7)	17	18	–DB (7)
DB (P)	19	20	DB (P)
DIFFSENS	21	22	GROUND
GROUND	23	24	GROUND
TERMPWR	25	26	TERMPWR
GROUND	27	28	GROUND
ATN	29	30	–ATN
GROUND	31	32	GROUND
BSY	33	34	–BSY
ACK	35	36	–ACK
RST	37	38	–RST
MSG	39	40	–MSG
SEL	41	42	–SEL
C/D	43	44	–C/D
REQ	45	46	–REQ
I/O	47	48	–I/O
GROUND	49	50	GROUND

* See Section 11.7.3.2 for detailed electrical characteristics of these differential signals.

11.9 SCSI wide physical interface

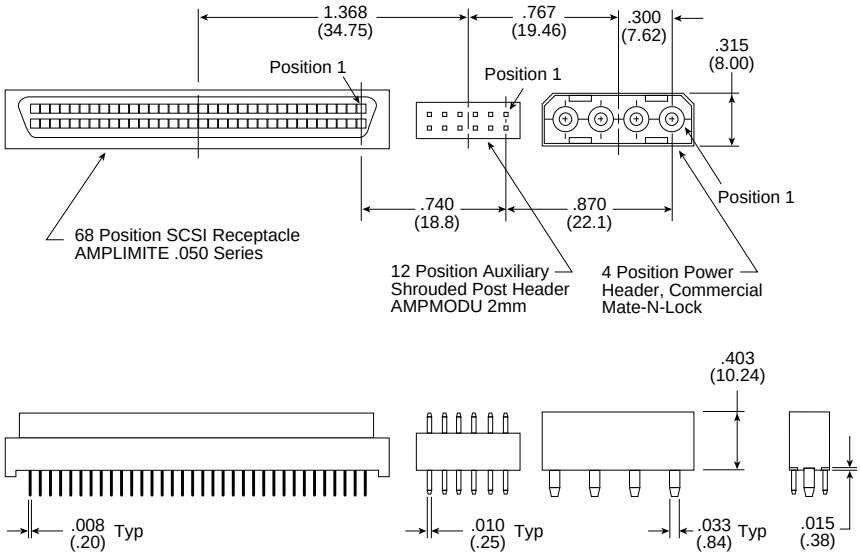


Figure 34. Wide SCSI device connector

Table 16. Single-ended contact assignments (P cable) for ST15150W 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 minus sign preceding a signal name indicates that signal is active low.
2. Eight-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), and –DB(P1). All other signals should be connected as defined.

Table 17. Differential contact assignments (P cable) for ST15150WD 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. Eight-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), and DB(11). All other signals should be connected as defined.

11.10 SCSI SCA physical interface

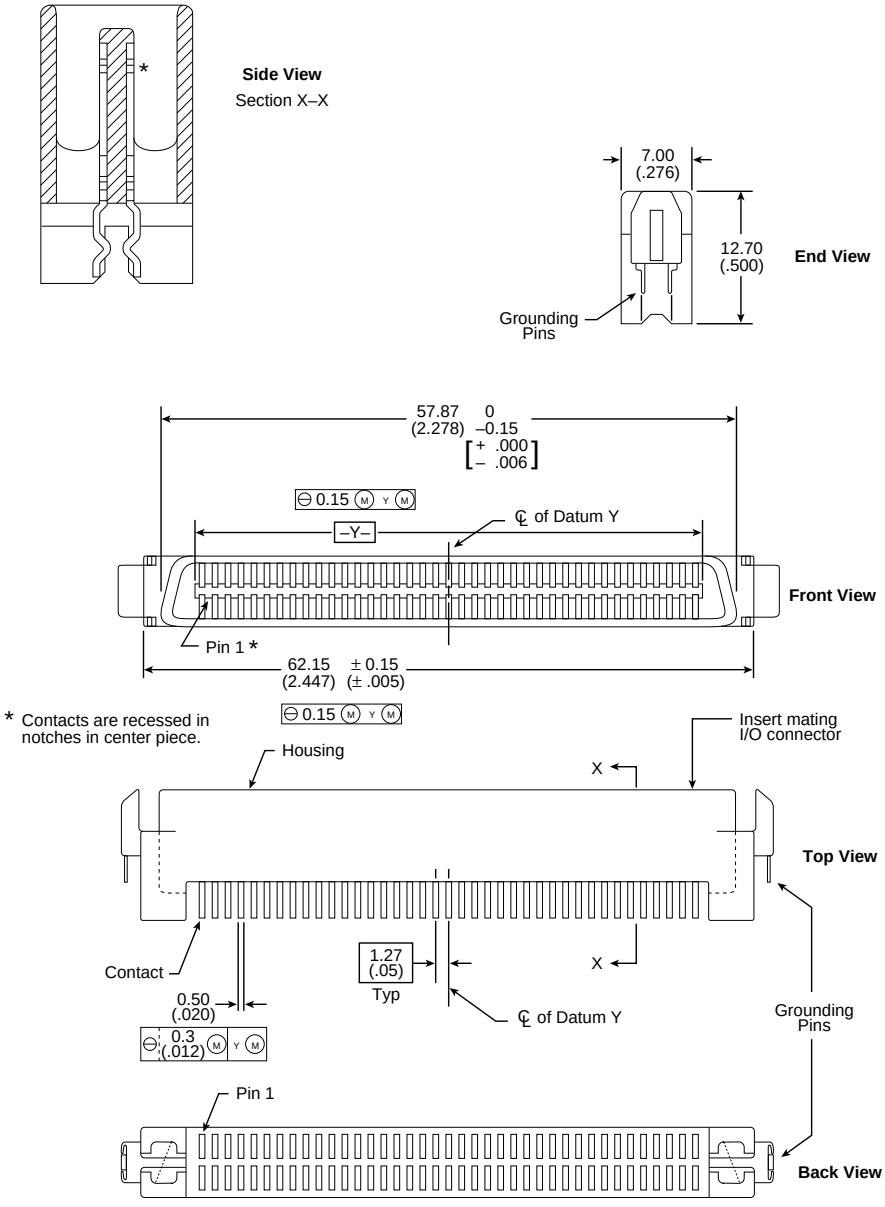


Figure 35. SCA SCSI device connector

Table 18. SCA contact assignments for ST15150WC drives

Signal name	Connector contact number	Connector contact number	Signal name
12 VOLT	1	41	12V GROUND
12 VOLT	2	42	12V GROUND
12 VOLT	3	43	12V GROUND
12 VOLT	4	44	12V GROUND
RESERVED/NC	5	45	RESERVED/NC
RESERVED/NC	6	46	GROUND
DB (11)	7	47	GROUND
DB (10)	8	48	GROUND
DB (9)	9	49	GROUND
DB (8)	10	50	GROUND
I/O	11	51	GROUND
REQ	12	52	GROUND
C/D	13	53	GROUND
SEL	14	54	GROUND
MSG	15	55	GROUND
RST	16	56	GROUND
ACK	17	57	GROUND
BSY	18	58	GROUND
ATN	19	59	GROUND
DB (P0)	20	60	GROUND
DB (7)	21	61	GROUND
DB (6)	22	62	GROUND
DB (5)	23	63	GROUND
DB (4)	24	64	GROUND
DB (3)	25	65	GROUND
DB (2)	26	66	GROUND
DB (1)	27	67	GROUND
DB (0)	28	68	GROUND
DB (P1)	29	69	GROUND
DB (15)	30	70	GROUND
DB (14)	31	71	GROUND
DB (13)	32	72	GROUND
DB (12)	33	73	GROUND
5 VOLT	34	74	5V GROUND
5 VOLT	35	75	5V GROUND
5 VOLT	36	76	5V GROUND
SYNC	37	77	ACTIVE LED OUT
RMT_START	38	78	DLYD_START
SCSI ID(0)	39	79	SCSI ID(1)
SCSI ID(2)	40	80	SCSI ID(3)

Notes:

1. The hyphen preceding a signal name indicates that signal is active low.
2. Eight-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), and DB(11). All other signals should be connected as defined.

Table 19. SCA contact assignments for ST15150DC drives

Signal name	Connector contact number	Connector contact number	Signal name
12 VOLT	1	41	12V GROUND
12 VOLT	2	42	12V GROUND
12 VOLT	3	43	12V GROUND
12 VOLT	4	44	12V GROUND
RESERVED/NC	5	45	RESERVED/NC
RESERVED/NC	6	46	DIFF SENSE
– DB (11)	7	47	+ DB (11)
– DB (10)	8	48	+ DB (10)
– DB (9)	9	49	+ DB (9)
– DB (8)	10	50	+ DB (8)
– 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
– DB (P0)	20	60	+ DB (P0)
– DB (7)	21	61	+ DB (7)
– DB (6)	22	62	+ DB (6)
– DB (5)	23	63	+ DB (5)
– DB (4)	24	64	+ DB (4)
– DB (3)	25	65	+ DB (3)
– DB (2)	26	66	+ DB (2)
– DB (1)	27	67	+ DB (1)
– DB (0)	28	68	+ DB (0)
– DB (P1)	29	69	+ DB (P1)
– DB (15)	30	70	+ DB (15)
– DB (14)	31	71	+ DB (14)
– DB (13)	32	72	+ DB (13)
– DB (12)	33	73	+ DB (12)
5 VOLT	34	74	5V GROUND
5 VOLT	35	75	5V GROUND
5 VOLT	36	76	5V GROUND
SYNC	37	77	ACTIVE LED OUT
RMT_START	38	78	DLYD_START
SCSI ID(0)	39	79	SCSI ID(1)
SCSI ID(2)	40	80	SCSI ID(3)

Note:

1. The hyphen preceding a signal name indicates that signal is active low.

11.11 Disc drive SCSI timing

Table 20. 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) This measures disconnected CMD overhead.	T11	4.5-6	Command dependent	
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 µs
Next command byte access		4.5-4		
Next CDB byte access (byte 2 of 6)	T23.6.2	4.5-4	0.55 µs	0.56 µs
Next CDB byte access (byte 3 of 6)	T23.6.3	4.5-4	0.10 µs	0.10 µs
Next CDB byte access (byte 4 of 6)	T23.6.4	4.5-4	0.09 µs	0.10 µs
Next CDB byte access (byte 5 of 6)	T23.6.5	4.5-4	0.13 µs	0.14 µs
Next CDB byte access (byte 6 of 6)	T23.6.6	4.5-4	0.13 µs	0.14 µs
	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

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	0.09 µs	0.04 µs
		4.5-8,14,15		
MSG OUT byte transfer	T33	4.5-2		0.04 µs
STATUS byte transfer	T34	4.5-5,8		0.04 µs
		4.5-15		
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 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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