Seagate

Barracuda 4FC Disc Drive

ST15150FC

Product Manual, Volume 1

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1.0 Scope

This manual describes Seagate Barracuda 4FC (Fibre Channel) disc drives.

Barracuda 4FC drives support the Fibre Channel Arbitrated Loop and SCSI Fibre Channel Protocol specifications to the extent described in this manual. The *Fibre Channel Arbitrated Loop Product Manual* (part number 77767496) describes the general Fibre Channel Arbitrated Loop characteristics of this and other Seagate Fibre Channel drives.

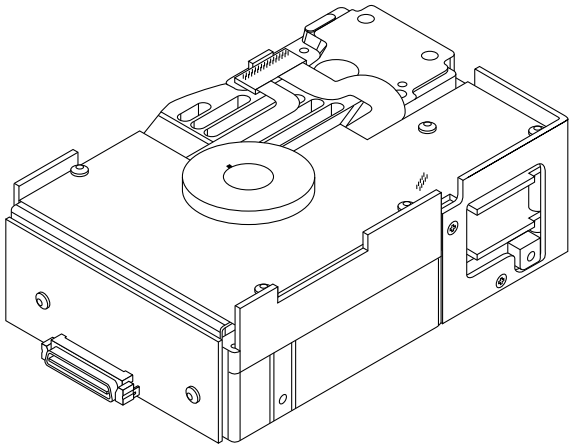


Figure 1. Barracuda 4FC family disc drive

2.0 Applicable standards 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 assemblies, such as the Barracuda 4FC 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 4FC disc drive is designed to be a UL recognized component per UL1950, CSA certified to CSA C22.2 No 950-M89, and VDE certified to VDE 0805 and EN60950.

The Barracuda 4FC disc drive is supplied as a component part. It is the responsibility of the subsystem designer to meet EMC/regulatory requirements established by the FCC, DOC, and VDE. Engineering test characterizations of radiated emissions are available from the Seagate safety department.

2.2 Reference documents

ST15150FC Installation Guide
Seagate part number: 83329070

Fibre Channel Arbitrated Loop (FC-AL) Product Manual
Seagate part number: 77767496

SCSI Interface Product Manual
Seagate part number: 77738479

ANSI Fibre Channel Documents

X3.230-199x	FC Physical and Signaling Interface (FC-PH)
X3.xxx-199x	FC Arbitrated Loop (FC-AL)
X3T10-993.D	Fibre Channel Protocol for SCSI (FCP)
TBD	Direct Disk Attachment Profile

ANSI Small Computer System Interface (SCSI) Documents

X3T9.2/86-109 Rev. 10H	(SCSI-2)
X3T10-994D	(SCSI-3) Architecture Model

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

3.0 General description

Barracuda 4FC drives are random access storage devices designed to support the Fibre Channel Arbitrated Loop (FC-AL) and SCSI Fibre Channel Protocol as described in the ANSI specifications, this document, and the *Fibre Channel Arbitrated Loop Product Manual* (part number 77767496) which describes the general interface characteristics of this drive.

You can view the Fibre Channel interface simply as a transport vehicle for the supported command set (ST15150FC drives use the SCSI command set). In fact, the Fibre Channel interface is unaware of the content or meaning of the information being transported. It simply packs the SCSI commands in packets, transports them to the appropriate devices, and provides error checking to ensure that the information reaches its destination accurately. Refer to the documents referenced in Section 2.2 if you require additional information about the Fibre Channel interface, FC-AL topology, or the SCSI fibre channel protocol.

The head and disc assembly (HDA) is environmentally sealed at the factory. Air recirculates 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. Never disassemble the HDA. This exploded view is for information only. Do not attempt to service items in the sealed enclosure (heads, media, actuator, etc.) as this requires special facilities. The drive contains no parts replaceable by the user and opening the HDA for any reason voids your warranty.

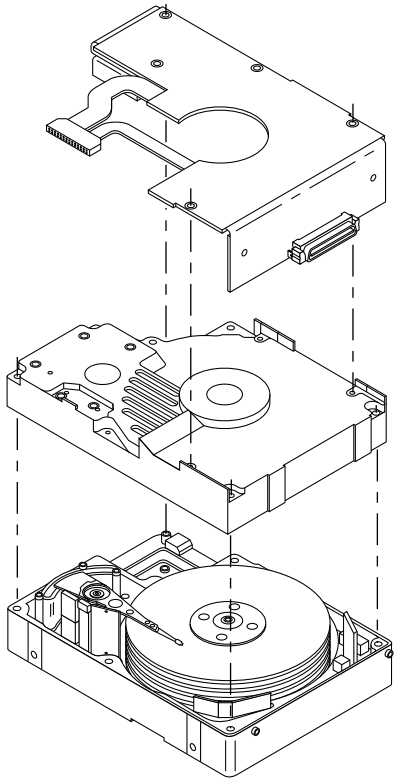


Figure 2. Barracuda 4FC disc drive

Barracuda 4FC 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 heads automatically go to the landing zone when power is removed from the drive.

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

Barracuda 4FC drives decode track 0 location data from the dedicated servo surface to eliminate mechanical transducer adjustments and related reliability concerns.

The drives also use a high-performance actuator assembly design that provides excellent performance with minimum power dissipation.

3.1 Standard features

Barracuda 4FC drives have the following standard features:

- Integrated dual port FC-AL controller
- Support for FC-AL (Fibre Channel Arbitrated Loop)
- Differential copper FC drivers and receivers
- Downloadable firmware using the FC-AL interface
- Drive selection ID and configuration options are set on the FC-AL backpanel, T-card, or through interface commands. Jumpers are not required on the drive.
- FC world-wide name uniquely identifies the drive and each port
- Supports up to 16 initiators
- User-selectable logical block size (180 to 4,096 bytes)
- Reallocation of defects on command (Post Format)
- User-selectable number of spare sectors per cylinder
- Industry standard 3.5-inch full-high form factor dimensions
- Programmable sector reallocation scheme
- Flawed sector reallocation at format time
- Programmable autowrite and 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
- 998 Kbyte data buffer

3.2 Media description

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

3.3 Performance

- Programmable multi-segmentable cache buffer
- 106.3 Mbytes/sec maximum instantaneous data transfers
- 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
- Adaptive seek velocity; improved seek performance

3.4 Reliability

- 800,000 hour MTBF (Class A computer room environment)
- Fibre Channel (FC) interface transports SCSI protocol through CRC protected frames
- LSI circuitry
- Balanced low mass rotary voice coil actuator

3.5 Unformatted and formatted capacities

The standard OEM models are formatted to 512 bytes per block.

ST15150FC drives have nine (9) spare sectors per cylinder and one (1) spare cylinder per unit.

	Formatted	Unformatted
ST15150FC	4,294 Mbytes	5,062 Mbytes

Users having the necessary equipment may modify the data block size before issuing a format command and obtain different formatted capacities than those listed. User-available capacity also depends on the spare reallocation scheme you select. See the Mode Select command and the Format command in the *Fibre Channel Arbitrated Loop Product Manual* (part number 77767496).

3.6 Factory-installed accessories

OEM standard drives are shipped with the Barracuda 4FC Installation Guide (part number 83329070).

3.7 Factory-installed options

You may order the following items which are incorporated at the manufacturing facility during production or packaged before shipping:

- Black plastic front panel with green lens (part number 70553702).*
- Black plastic front panel with red lens (part number 70553701).*
- 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.
- ST15150FC Installation Guide, part number 83329070.

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

3.8 User-installed accessories

The following accessories are available. All kits may be installed in the field.

- Front panel kit (green lens), part number 70869751.
- Single-unit shipping pack kit.
- Adapter accessory frame kit, part number 75790701.
  (adapts a 3.5-inch drive to fit in a 5.25-inch drive mounting space).
  This kit contains the frame to allow a 3.5-inch drive to be mounted in a 5.25-inch drive bay. It includes mounting hardware, front panel with a green lens, an LED with cable that connects to the remote LED connector, and installation instructions.
- Evaluation kit, part number 70935895.
  This kit provides an adapter card (“T-card”) to allow cable connections for two FC interfaces and DC power. Two twin axial cables, 6-feet in length, are included for the input and output connections to the FC interfaces. A small DC fan is included for cooling.

4.0 Performance characteristics

This section provides detailed information concerning performance-related characteristics and features of Barracuda 4FC drives.

4.1 Internal drive characteristics

	ST15150FC	
Drive capacity	5.062	Gbytes (unformatted)
Read/write data heads	21	
Bytes per track	64,160	Bytes (average)
Bytes per surface	232.4	Mbytes (unformatted)
Cylinders/tracks per surface	3,711	Tracks (user accessible)
Tracks per inch	4,048	TPI
Bits per inch	73,820	BPI
Servo heads	1	
Internal data rate	47.5 - 72.0	Mbytes/sec (variable with zone)
Disc rotation speed	7,200 ± 0.5%	rpm
Avg rotational latency	4.17	msec

4.2 Seek performance characteristics

All performance characteristics assume that thermal calibration is not in process when the SCSI command is received. A SCSI command being executed is not interrupted for thermal calibration. If thermal calibration is in process when a SCSI command is received, the command is queued until the compensation for the specific head being calibrated completes. When compensation completes for the specific head being calibrated, the first queued SCSI command is executed.

Refer to paragraph 9.6, “FC-AL physical interface” and to the *Fibre Channel Arbitrated Loop Product Manual* (part number 77767496) for additional timing details.

4.3 Thermal calibration

ST15150FC drives use an automatic thermal calibration (TCAL) process to maintain accurate head alignment with the data cylinders. The host sytem may choose to allow the drive to perform TCAL at the drive’s predefined intervals or the Rezero Unit command may be issued by the host to reset the TCAL timer so that the host knows when the TCAL will occur.

1. At power up and following a SCSI reset, the drive calibrates all of the heads before any read or write commands are processed. All heads are also calibrated during the SCSI Rezero Unit command.
2. The drive delays 300 seconds before initiating any TCALs. No TCALs occur during this delay period.
3. A single-head TCAL is then scheduled at 7.1 second intervals.
4. After the drive TCALs all of the heads, the interval is increased to schedule a single head TCAL every 14.3 seconds.
5. The drive attempts to find an idle period of 25 to 50 milliseconds prior to performing a single head TCAL. If this TCAL is delayed for another interval of time, the drive forces the TCAL at the next command boundary. This guarantees that no head will remain uncalibrated for more than 600 seconds (2 * 21 heads * 14.3 seconds per head) and that no TCALs are closer together than the interval time.

Note. Any TCAL performed during the “standard” retry sequence is limited to the failing head and is disabled if the host has selects a retry count of zero.

4.3.1 Seek time

	Drive level (msec)		Including drive controller overhead[1] (msec)	
	Read	**Write**	**Read**	**Write**
Average typical[2]	8.0	9.0	9.0	10.0
Single track typical[2]	0.6	0.9	1.6	1.9
Full stroke typical[2]	17	19	18.0	20.0

1. Rate measured from the start of the first sector transfer to or from the host.
2. Typical seek values are measured under nominal conditions of temperature, voltage, and horizontal orientation as measured on a representative sample of drives.

4.3.2 Format command execution time for ≥ 512-byte sectors

Maximum (with verify)	60 minutes
Maximum (without verify)	40 minutes

4.3.3 General performance characteristics

Minimum sector interleave	1 to 1
Data buffer to/from disc media (512-byte sector)	
Data transfer burst rate (≤ 1 sector)	
Min	5.30 Mbytes/sec*
Max	8.94 Mbytes/sec*
Data transfer sustained rate (< 1 track)	
Min (divided by interleave factor)	3.56 Mbytes/sec*
Max (divided by interleave factor)	7.65 Mbytes/sec*
FC-AL interface data	
Maximum instantaneous transfer rate	106.3 Mbytes/sec
Sector sizes	
Default is 512-byte data blocks	
Variable (180- to 4,096-bytes) in multiples of four bytes	
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 (512 byte sectors)	0.7 msec
Overhead time for one track cylinder switch	1.6 msec (typical)
Average rotational latency	4.17 msec

*Assumes no errors and no relocated sectors.

4.4 Start/stop time

If the Motor Start option is disabled, the drive becomes ready with 30 seconds after DC power is applied. If a recoverable error condition is detected during the start sequence, the drive executes a recovery procedure and the time to become ready may exceed 30 seconds. During the start sequence, the drive responds to some commands over the FC-AL interface. Stop time is less than 30 seconds (maximum) from removal of DC power.

If the Motor Start option is enabled, the internal controller accepts the commands listed in the *FC-AL Interface Product Manual* less than 3 seconds after DC power has been applied. After the Motor Start command has been received, the drive becomes ready for normal operations within 30 seconds (excluding the error recovery procedure). The Motor Start command can also be used to command the drive to stop the spindle (see Start/ Stop command information in the *Fibre Channel Arbitrated Loop Product Manual*).

There is no power control switch on the drive.

4.5 Prefetch/multi-segmented cache control

The drive provides a prefetch/multi-segmented cache algorithm that in many cases can enhance 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 *Fibre Channel Arbitrated Loop Product Manual*). Default is prefetch and read cache enabled.

4.6 Cache operation

Of the 1,024 Kbytes physical buffer space in the drive, 998 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 in the *Fibre Channel Arbitrated Loop 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 *Fibre Channel Arbitrated Loop Product Manual*). If the cache is not enabled, 998 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 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 *Fibre Channel Arbitrated Loop 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 *Fibre Channel Arbitrated Loop 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, and 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 *Fibre Channel Arbitrated Loop 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 *Fibre Channel Arbitrated Loop 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. The drive supports operation of any integer number of

segments from 1 to 16. Divide the 998 Kbytes in the buffer by the number of segments to get the segment size. Default is 3 segments. (See the *Fibre Channel Arbitrated Loop Product Manual*.)

4.6.1 Caching write data

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

Write caching is enabled independently of read caching. The default write cache setting for ST15150FC drives is with write caching disabled. To enable the write cache, use the Write Caching Enable (WCE) bit.

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 that are to be written are already stored in the cache from a previous read or write command. If there are, the respective cache segments are cleared. The new data is cached for subsequent read commands.

If 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 need be, for any logical blocks that are being written (see the *Fibre Channel Arbitrated Loop 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 medium.

4.7 Synchronized spindle operation

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 spindle sync signal is routed in the backpanel to connect the drives in the synchronized system as shown in Figure 3.

Each drive in the system can be configured by the host (using a Mode Select command) to operate in either the master or slave mode. Drives can be re-configured by the host any time after power-up to be master or slave by use of the Mode Select command 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 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 is to provide the reference signal. If the host does not provide the reference signal, the host should not be connected.

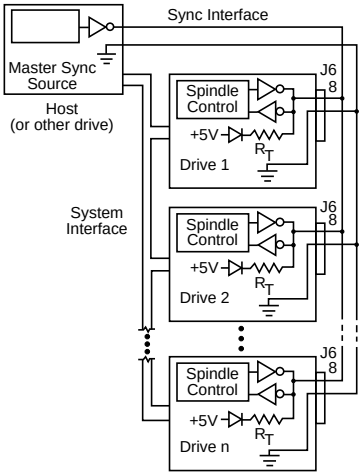


Figure 3. Synchronized drive interconnect diagram

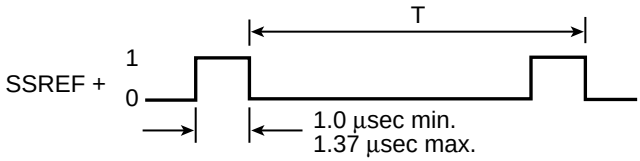
Rotational Position Locking

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

RPL	Description
00b	Indicates that 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 4 shows the characteristics of the reference signal.



T = 0.0083 second (± 1.0% max); ± 10 µsec cycle to cycle variance; ± 20 µsec phase error while synchronized

Figure 4. Synchronized reference signal characteristics

SCSI factors

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

If subsequent to achieving synchronization the target detects a change of synchronization and:

1. If the logical unit is not executing an I/O process for the initiator, the target creates a unit attention condition. The sense key is set to Unit Attention and the additional sense code set to Spindle Synchronized (5C01) or Spindle Not Synchronized (5C02).
2. If the logical unit is executing an I/O process and no other error occurs, 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 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).

The drive may be operated 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. The amount of offset is selected by using the Mode Select command, Rigid Disc Drive Geometry page (page 04), byte 18 (see the *Fibre Channel Arbitrated Loop 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 ±20 µsec 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. Such correspondences or changes, if required, must be formulated by the initiator for it to calculate the value of offset it sends to the drive.

5.0 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 media error rate (using default settings):	Less than 10 errors in 10^{11} bits transferred
Unrecovered media data:	Less than 1 sector in 10^{14} bits transferred
Miscorrected media data:	Less than 1 sector in 10^{21} bits transferred
Interface error rate:	Less than 1 error in 10^{12} bits transferred with minimum receive eye. Less than 1 error in 10^{14} bits transferred with typical receive eye. See Section 9.7.5, “Differential PECL input.”
MTBF:	800,000 hours
Service life:	5 years
Preventive maintenance:	None required

5.1 Error rates

The error rates stated in this manual assume the following:

- The drive is operated in accordance with this manual using DC power as defined in paragraph 6.2, “DC power requirements.”
- The drive has been formatted with the SCSI format commands.
- Errors caused by media defects or host system failures are excluded from error rate computations. Refer to Section 3.2, “Media description.”

5.1.1 Environmental interference

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

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

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

5.1.2 Interface errors

An interface error is defined as a failure of the receiver on a port to recover the data as transmitted by the device port connected to the receiver. The error may be detected as a running disparity error, illegal code, loss of word sync, or CRC error. The total error rate for a loop of devices is the sum of the individual device error rates.

5.1.3 Write errors

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

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

5.1.4 Seek errors

A seek error is defined as a failure of the drive to position the heads to the addressed track. There 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 paragraph 5.1.1.2 of *Fibre Channel Arbitrated Loop Product Manual* (part number 77767496).

5.2 Reliability and service

The reliability of Barracuda 4FC disc drives can be enhanced by ensuring that the drive receives adequate cooling. This section provides recommended air-flow information, temperature measurements, and other information, which may be used to enhance the service life of the drive.

5.2.1 Mean time between failure (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 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.

5.2.2 Preventive maintenance

No routine scheduled preventive maintenance is required.

5.2.3 Service life

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

5.2.4 Service philosophy

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

5.2.5 Service tools

No special tools are required for site installation or recommended for site maintenance. Refer to paragraph 5.2.2, “Preventive maintenance.” The depot repair philosophy of the drive precludes the necessity for special tools. Field repair of the drive is not practical because users cannot purchase individual parts for the drive.

5.2.6 Product warranty

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

Shipping

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

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

Product repair and return information

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

5.2.7 Hot plugging the drive

Inserting and removing the drive on the FC-AL will disrupt loop operation. The disruption occurs when the receiver of the next device in the loop must synchronize to a different input signal. FC error detection mechanisms, character sync, running disparity, word sync, and CRC are able to detect any error. Recovery is initiated based on the type of error.

The Barracuda 4FC disc drive defaults to the FC-AL Monitoring state, Pass-through state, when it is powered-on by switching the power or hot plugged. The control line to an optional port bypass circuit (external to the drive), defaults to the Enable Bypass state. If the bypass circuit is present, the next device in the loop will continue to receive the output of the previous device to the newly inserted device. If the bypass circuit is not present, loop operation is temporarily disrupted until the next device starts receiving the output from the newly inserted device and regains synchronization to the new input.

The Pass-through state is disabled while the disc performs self test of the FC interface. The control line for an external port bypass circuit remains in the Enable Bypass state while self test is running. If the bypass circuit is present, loop operation may continue. If the bypass circuit is not present, loop operation will be halted while the self test of the FC interface runs.

When the self test completes successfully, the control line to the bypass circuit is disabled and the drive enters the FC-AL Monitoring state, Pass-though state. The receiver on the next device in the loop must synchronize to output of the newly inserted drive.

If the self test fails, the control line to the bypass circuit remains in the Enable Bypass state.

Note: It is the responsibility of the systems integrator to assure that no temperature, energy, or voltage hazard is presented during the hot connect/disconnect (hot plug) operation. Discharge the static electricity from the drive carrier prior to inserting it into the system.

6.0 Physical/electrical specifications

This section provides information relating to the physical and electrical characteristics of Barracuda 4FC disc drives.

6.1 AC power requirements

None.

6.2 DC power requirements

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

Table 1: DC power requirements

Voltage Regulation	Notes [5]	+5V ±5V (Amps)	+12V ±5V[2] (Amps)
Avg idle current	[1] [8]	1.03	1.25
Max start current (peak DC)	[3] [6]	1.44	2.42
Delayed motor start (max)	[1] [4]	1.23	0.67
Operating current			
Typical	[1] [7]	1.28	1.42
Maximum	[1]	1.32	1.49
Max (peak)		1.46	2.35

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

[2] A -10% tolerance is allowed during initial spindle start but must return to ±5% before reaching 7,200 RPM. 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 +12V current profile in Figure 5.

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

[5] See paragraph 6.2.1, “Conducted noise immunity.” Specified voltage tolerance includes 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] Operating condition means a third stroke seek at OD and Read One track. A command is issued every 0.075 seconds.

[8] All power-saving features enabled.

General DC power requirement notes.

1. Minimum current loading for each supply voltage is not less than 7% of the maximum operating current shown.
2. The +5V and +12V supplies should employ separate ground returns.
3. Where power is provided to multiple drives from a common supply, careful consideration for individual drive power requirements should be noted. Where multiple units are powered on simultaneously, the peak starting current must be available to each device.

6.2.1 Conducted noise immunity

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

	+5V	+12V (with spindle motor not running)
0 to 100 kHz	150mV	150mV
100 kHz to 10 MHz	100mV	100mV

6.2.2 Power sequencing

The drive does not require power sequencing. The drive protects against inadvertent writing during power-up and down.

6.2.3 12V current profile

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

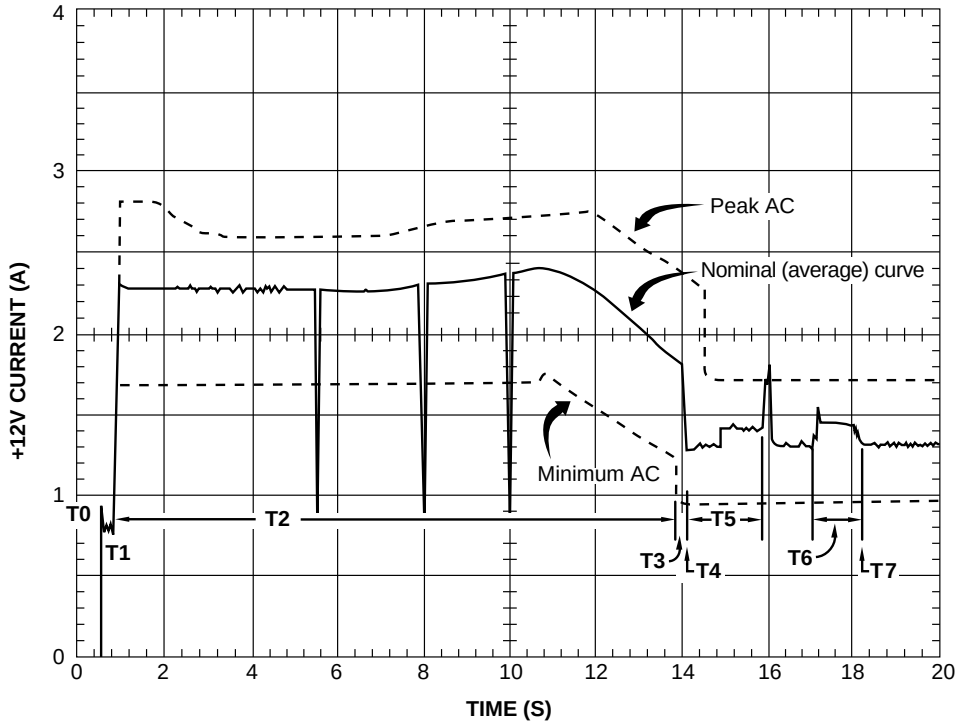


Figure 5. Typical Barracuda 4FC drive +12V current profile

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.
T3 The spindle is up to speed and the Head-Arm restraint is unlocked.
T4 Heads move from the landing zone to the data area.
T5 The adaptive calibration sequence is performed.
T6 Calibration is complete and the drive is ready for reading and writing.

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

6.3 Power dissipation

Typical seek power dissipation is 23 watts (79 BTUs per hour) of DC power average at nominal voltages. Typical power dissipation under idle conditions is 20 watts (68 BTUs per hour).

6.4 Environmental limits

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

6.4.1 Temperature

a. Operating

The MTBF specification for the drive (800,000 hours) is based on operating at a local ambient temperature of 95°F (35°C). Occasional excursions to drive ambient temperatures to 122°F (50°C) may occur without impact to specified MTBF. The enclosure for the drive should be designed such that the case temperatures at the locations specified in Figures 11 and 12 are not exceeded. Air flow is needed to achieve these temperature values. Continual or sustained operation at case temperatures above these values may degrade MTBF.

The drive meets all specifications over a 41°F to 122°F (5°C to 50°C) drive ambient temperature range with a maximum gradient of 36°F (20°C) per hour when the case temperature limits specified above are not exceeded.

b. Non-operating

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

6.4.2 Relative humidity

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

a. Operating

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

b. Non-operating

5% to 95% relative humidity.

6.4.3 Effective altitude (sea level reference)

a. Operating

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

b. Non-operating

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

6.4.4 Shock and vibration

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

The limits of shock and vibration defined within this document are specified with the drive mounted in one of the two methods shown in Figure 9.

6.4.4.1 Shock

a. Operating (normal)

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

b. Operating (abnormal)

Equipment as installed for normal operation shall not incur physical damage while subjected to intermittent shock not exceeding 10 Gs at a maximum duration of 11 msecs (half sinewave). Shock occurring at abnormal levels may promote degraded operational performance during the abnormal shock period. Specified operational performance will continue when normal operating shock levels resume. Shock may be applied in the X, Y, or Z axis. Shock is not to be repeated more than two times per second.

c. Non-operating

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

The drive subjected to non-repetitive shock not exceeding 50 Gs at a maximum duration of 11 msecs (half sinewave) will not exhibit device damage or performance degradation. Shock may be applied in the X, Y, or Z axis.

d. Packaged

The drive as packaged in a single or multiple drive pack of gross weight 20 pounds (8.95 kg) or less by Seagate for general freight shipment shall withstand a drop test from 48 inches (1,070 mm) against a concrete floor or equivalent.

6.4.4.2 Vibration

a. Operating (normal)

The drive as installed for normal operation shall operate 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 (abnormal)

Equipment as installed for normal operation shall 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 will continue 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 shall apply to all conditions of handling and transportation. This includes both isolated drives and integrated drives.

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

5-22 Hz @ 0.040 in. (1.02 mm) displacement
22-400 Hz @ 2.00 Gs

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

6.4.5 Air cleanliness

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

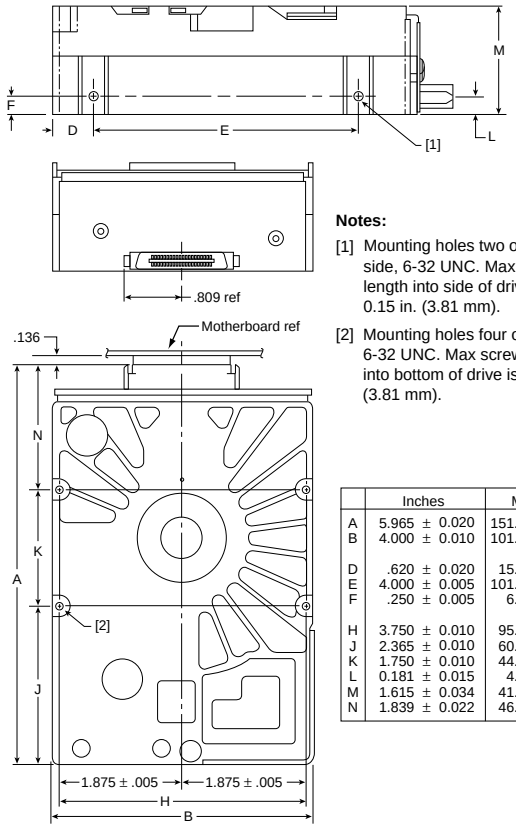
6.5 Electromagnetic susceptibility

As a component part, the drive is not required to meet any susceptibility performance requirements. It is the responsibility of the system integrator to perform tests required to ensure that equipment operating in the same system as the drive does not adversely affect the performance of the drive. See paragraph 6.2, “DC power requirements.”

6.6 Mechanical specifications

The following nominal dimensions are exclusive of the decorative front panel accessory. Refer to Figure 6 for detailed mounting configuration dimensions for the drive. A minimum clearance of 0.050 in. (1.27 mm) 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 kilograms



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).

	Inches	Millimeters
A	5.965 ± 0.020	151.511 ± .508
B	4.000 ± 0.010	101.60 ± .25
D	.620 ± 0.020	15.748 ± .50
E	4.000 ± 0.005	101.60 ± .13
F	.250 ± 0.005	6.35 ± .13
H	3.750 ± 0.010	95.25 ± .25
J	2.365 ± 0.010	60.071 ± .25
K	1.750 ± 0.010	44.45 ± .50
L	0.181 ± 0.015	4.59 ± .381
M	1.615 ± 0.034	41.021 ± .863
N	1.839 ± 0.022	46.70 ± .56

Figure 6. Mounting configuration dimensions

7.0 Defect and error management

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

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

7.1 Drive internal defects/errors

Identified defects are recorded on the drive defects list tracks (referred to as the primary or ETF defect list). These known defects are reallocated during the initial drive format operation at the factory. See the Format Unit command in the *Fibre Channel Arbitrated Loop Product Manual* (part number 77767496). Data correction by ECC is applied to recover data from additional flaws if they occur.

Details of the SCSI commands supported by the drive are described in the *Fibre Channel Arbitrated Loop Product Manual*. Also, more information on the drive Error Recovery philosophy is presented in the *Fibre Channel Arbitrated Loop Product Manual*.

8.0 Installation

ST15150FC disc drive installation is a plug-and-play process. There are no jumpers, switches, or terminators on the drive which need to be set. Simply plug the drive into the host's 40-pin Fibre Channel backpanel connector (FC-SCA)–no cables are required. Refer to Section 9.6 on page 41 for additional information about this connector.

The FC-AL interface is used to select drive ID and all option configurations for devices on the loop.

If multiple devices are on the same FC-AL and physical addresses are used, set the device selection IDs (SEL IDs) on the backpanel so that no two devices have the same selection ID. This is called the hard assigned arbitrated loop physical address (AL_PA). There are 125 AL_PAs available (see Table 18 on page 47). If you set the AL-PA on the backpanel to any value other than 0, the device plugged into the backpanel's SCA connector inherits this AL_PA. In the event you don't successfully assign unique hard addresses (and therefore have duplicate selection IDs assigned to two or more devices), the FC-AL generates a message indicating this condition. If you set the AL-PA on the backpanel to a value of 0, the system issues a unique soft-assigned physical address automatically.

Loop initialization is the process used to verify or obtain an address. The loop initialization process is performed when power is applied to the drive, when a device is added or removed from the FC loop, or when a device times out attempting to win arbitration.

- Set all option selections in the connector prior to applying power to the drive. If you change options after applying power to the drive, recycle the drive power to activate the new settings.
- It is not necessary to low level format this drive. The drive is shipped from the factory low level formatted in 512-byte sectors. You need to reformat the drive only if you want to select a different sector size or if you select a different spare sector allocation scheme.

8.1 Drive ID/option selection

All ST15150FC drive options are made through the interface connector (J6). Table 15 on page 43 provides the pin descriptions for the 40-pin FC single connector (J6).

8.2 LED connections

A connector, J20, is provided on the LYJX board to provide port bypass, drive active, and drive fault LED connections (see Figure 8). Refer to Section 9.6.5.3 for a description of the Port Bypass LED function. Refer to Section 9.6.5.2 for a description of the Active LED function. Refer to Section 9.6.4.3 for a description of the Fault LED function.

Note. The LYJX-0 board does not have the J20 connector.

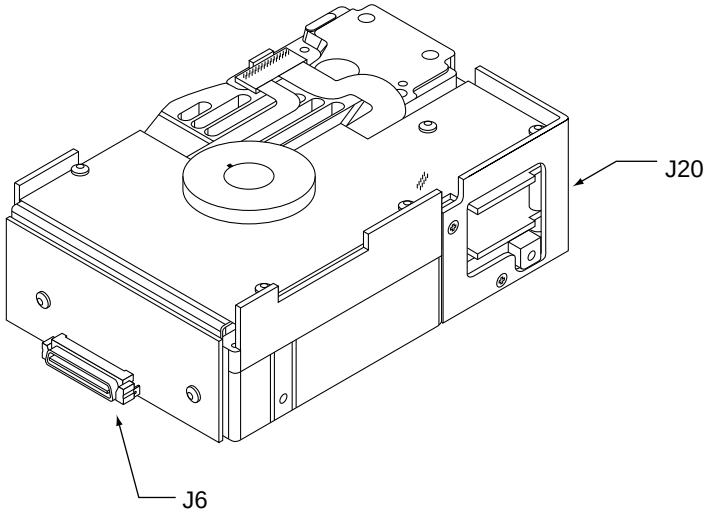


Figure 7. Barracuda 4FC drive physical interface

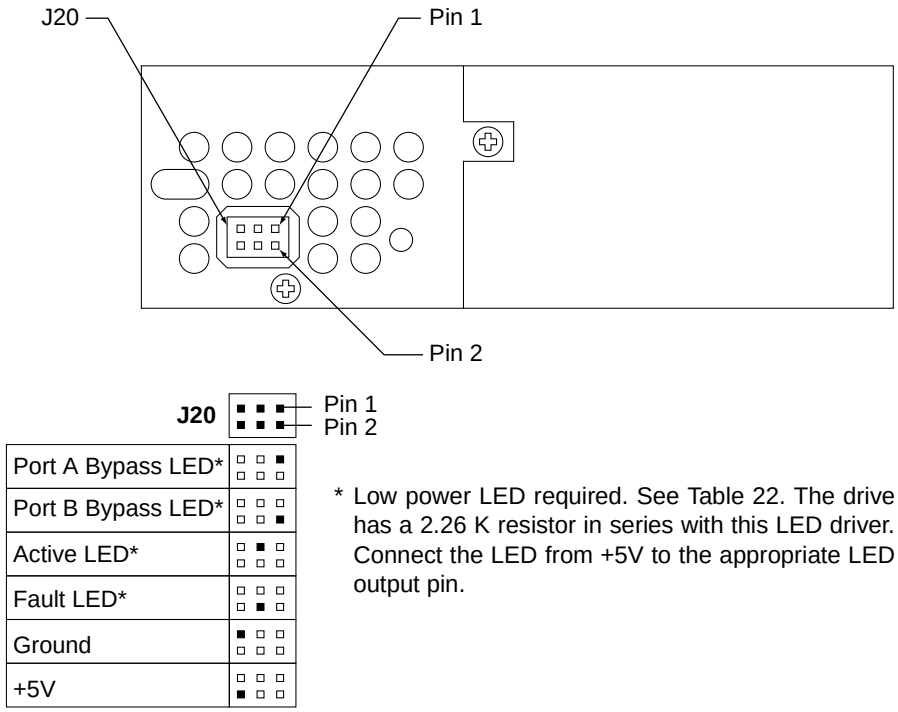


Figure 8. Barracuda 4FC LED indicator connector

8.2.1 J20 connector requirements

Recommended mating connector part number: Berg receptacle, 6-position, part number 690-006.

8.3 Drive orientation

The drive may be mounted in any orientation. All drive performance characterizations, however, have been done with the drive in horizontal (discs level) and vertical (drive on its side) orientations, which are the two preferred mounting orientations.

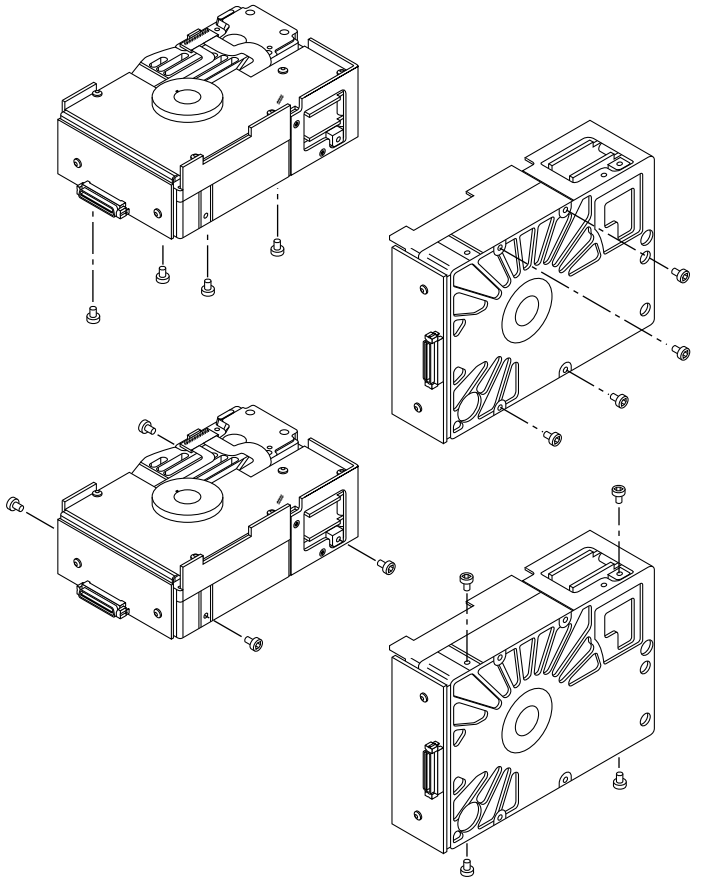


Figure 9. Recommended mounting

8.4 Cooling

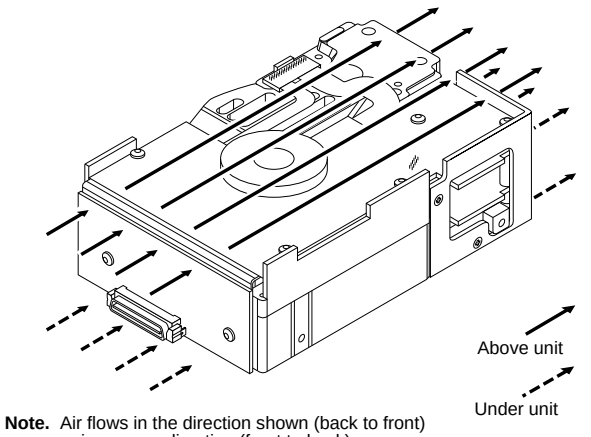
Cabinet cooling must be designed by the customer so that the ambient temperature immediately surrounding the drive will not exceed temperature conditions specified in Section 6.4.1, “Temperature.” Specific consideration should be given to make sure adequate air circulation is present around the printed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

8.4.1 Air flow

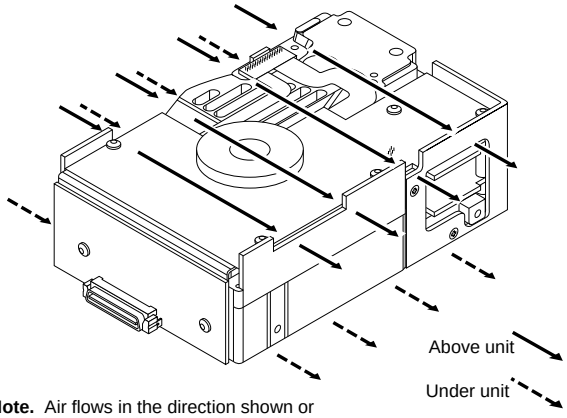
The rack, cabinet, or drawer environment for the Barracuda 4FC drive must provide cooling of the electronics and head and disc assembly (HDA). You should confirm that adequate cooling is provided using the temperature measurement guidelines described below.

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

Possible air flow patterns are shown in Figure 10. The air flow patterns are created by one or more fans, either forcing or drawing air as shown in the illustrations. Other air flow patterns are acceptable as long as the temperature measurement guidelines 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 10. Air flow

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

Air flow cooling

Card	Component	Reference	MTBF 800k hours case temperature (°C)
LYJX	Transmitter	1	76
LYJX	Writer	2	62
LYJX	Memory	3	51
LYJX	Aurora	4	73
LYJX	Driver	5	55

To obtain the maximum temperature for each of the reference components listed, add 15°C to the 800K 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.

The air-flow pattern with which the temperature guidelines above were generated is shown in Figure 10. Local average air velocities were 1.2 m/sec (230 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 (see Figure 12)

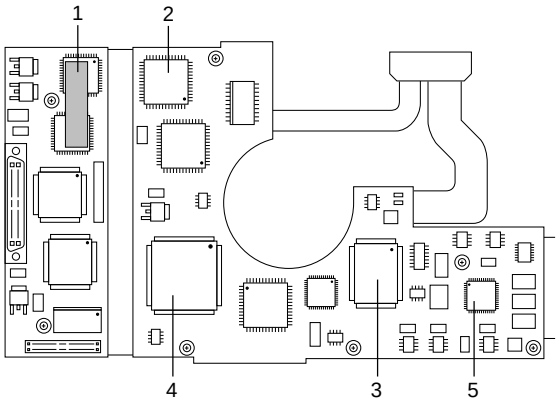


Figure 11. LYJX temperature measurement locations

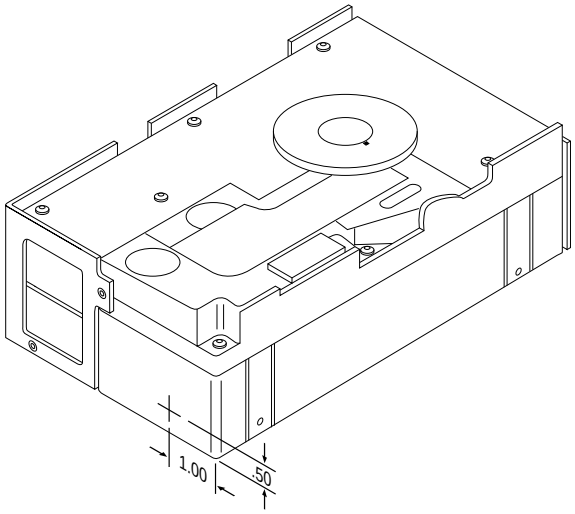


Figure 12. HDA case temperature measurement location

8.5 Drive mounting

Mount the drive using the bottom or side mounting holes. If you mount the drive using the bottom holes, ensure that you do not physically distort the drive by attempting to mount it on a stiff, non-flat surface.

The allowable mounting surface stiffness is 80 lb/in (14.0 N/mm). The following equation and paragraph define the allowable mounting surface stiffness:

$$k = \frac{F}{x} = \frac{80\ lb}{in} \text{ or } \frac{14.0\ N}{mm}$$

where k is the mounting surface stiffness (units in pounds or newton) and x is the out-of-plane distortion (units in inches or millimeters). The out-of-plane distortion (x) is determined by defining a plane with three of the four mounting points fixed and evaluating the out-of-plane defection of the fourth mounting point when a known force (F) is applied to the fourth point.

8.6 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.

9.0 Interface requirements

This section partially describes the interface requirements as implemented on ST15150FC drives. Additional information is provided in the *Fibre Channel Arbitrated Loop Interface Product Manual* (part number 77738479).

9.1 General description

The major portion of the interface requirements/implementation is described in the Seagate *Fibre Channel Arbitrated Loop Interface Product Manual*. This section provides information about ST15150FC drive implementation of the FC-AL standard.

9.2 FC-AL features

This section lists the Fibre Channel-specific features supported by ST15150FC drives.

9.2.1 Fibre Channel link service frames

Table 2 lists the link services supported by ST15150FC drives.

Table 2: Link services supported

Type of frame	Link service
Basic link service frames	Abort Sequence (ABTS)
Basic link service reply frames	Basic_Accept (BA_ACC) Basic_Reject (BA_RJT)
Extended link service frames	N_Port Login (PLOGI) Logout (LOGO) Process Login (PRLI) Process Logout (PRLO) Read Link Status (RLS) Port Discovery (PDISC)
Extended link service reply frames	Accept (ACC) Link Service Reject (LS_RJT)

9.2.2 Fibre Channel task management functions

Table 3 lists the FC SCSI FCP task management functions supported.

Table 3: Fibre Channel SCSI FCP task management functions

Task name	Supported
Terminate task	No
Clear ACA	Yes
Target reset	Yes
Clear task set	Yes
Abort task set	Yes

9.2.3 Fibre Channel task management responses

Table 4 lists the Fibre Channel SCSI FCP response codes returned for task management functions supported.

Table 4: FC SCSI FCP response codes

Function name	Response code
Function complete	00
Function not supported	04
Function reject	05

9.2.4 Fibre Channel port login

Table 5 identifies the required content of the N_Port Login (PLOGI) payload from an initiator.

Table 5: N_Port login (PLOGI) payload

Bytes																	
0-15	03	00	00	00	09	09	bb	bb	cf	XX	fs	fs	XX	XX	XX	XX	Common
16-31	XX	XX	XX	XX	PN	PN	PN	PN	PN	PN	PN	PN	NN	NN	NN	NN	
32-35	NN	NN	NN	NN													
36-47					XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	Class 1
48-51	XX	XX	XX	XX													
52-63					XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	Class 2
64-67	XX	XX	XX	XX													
68-79					so	so	ic	ic	XX	XX	fs	fs	XX	cs	XX	XX	Class 3
80-83	os	os	XX	XX													
84-95					XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	Reserved
96-99	XX	XX	XX	XX													
100-111					XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	XX	Vendor
112-115	XX	XX	XX	XX													Version

X Indicates a four bit (hex) field is not checked.

x Indicates a single bit is not checked.

bb BB-Credit. This field is not checked. The FC-AL drive uses BB-Credit of zero.

cf Common features. This binary field selects the common features requested by the initiator login.

MSB	Continuously increasing offset	Must = 1
	Random relative offset	Not checked. Port Login Accept will return a 0—not supported.
	Valid version level	x
	N_Port/F_Port	Must = 0, N_Port
	Alternate credit model	Must = 1
	Other bits reserved	XXX

fs Receive buffer field size. The fs field in the common and Class 3 parameters is checked for the range 128≤ fs ≤ 2112 and a multiple of four bytes. For multiple frame sequences, all frames but the last frame of the sequence must be this size. Only the receive buffer field size in the Class 3 parameters is used.

PN Port name (initiator's)—saved with the login parameters. If a change of the port name/AL_PA address association is detected during a Port DISCovery, an implicit logout occurs and a LS_RJT is returned to the initiator.

NN Node name. The node name is not checked or saved by the drive.

so Service options Class 3 only

MSB	Class valid	Must = 1
	Intermix	x
	Stacked connection required	xx
	Sequential delivery	x
	Other bits reserved	xxx

ic Initiator control

MSB	XID reassign	xx
	Proc Assc	10 or 11 causes the login to be rejected. Other values are accepted.
	ACK_0	xx
	ACK_N	xx

cs Concurrent sequences — Must be a value greater than 0.

os Open sequences per exchange — Must be a value greater than 0.

9.2.5 Fibre Channel port login accept

Table 6 identifies the N_Port Login payload values.

Table 6: N_Port Login (ACC) payload

Bytes																	
0-15	02	00	00	00	09	09	00	00	88	00	fs	fs	00	FF	00	01	Common
16-31	00	00	01	F4	10	PP	00	20	37	ui	ui	ui	10	00	00	20	
32-35	37	ui	ui	ui													
36-47					00	00	00	00	00	00	00	00	00	00	00	00	Class 1
48-51	00	00	00	00													
52-63					00	00	00	00	00	00	00	00	00	00	00	00	Class 2
64-67	00	00	00	00													
68-79					80	00	00	00	00	00	fs	fs	00	FF	00	00	Class 3
80-83	00	01	00	00													
84-95					00	00	00	00	00	00	00	00	00	00	00	00	Reserved
96-99	00	00	00	00													
100-111					00	00	00	00	00	00	00	00	00	00	00	00	Vendor -
112-115	00	00	00	00													Version

fs Receive buffer field size. The drive returns the fs from the login payload Class 3 parameters in the Common and Class 3 fields of the Accept payload.

ui Unique identifier. This 24-bit field is uniquely assigned to the drive. This same ui appears in the Port Name and Node Name.

pp Port identifier field

01 P_LOGI received on Port A.

02 P_LOGI received on Port B.

9.2.6 Fibre Channel Process Login (PRLI)

Table 7 lists ST15150FC process login payload data.

Table 7: Process Login (PLRI) payload

Bytes																
0-15	20	10	00	14	08	00	20	00	XX	XX	XX	XX	XX	XX	XX	XX
16-19	00	00	00	22												

XX Indicates fields that are not used.

9.2.7 Fibre Channel Process Accept (ACC)

Table 8 lists ST15150FC process login accept payload data.

Table 8: Process Login Accept (ACC) payload

Bytes																
0-15	02	10	00	14	08	00	21	00	00	00	00	00	00	00	00	00
16-19	00	00	00	12												

9.2.8 Fibre Channel Arbitrated Loop options

Table 9 lists the FC-AL options supported by ST15150FC drives.

Table 9: FC-AL options supported

Option	Supported
OPEN Half Duplex	Sent to open another device. Accepted from another device.
OPEN Full Duplex	Accepted from another device.
Private Loop	Yes
Public Loop	No
Old Port State	No
Loop Position	Yes
Loop Position Report	Yes

9.3 Dual port support

ST15150FC drives have two ports for connection to two independent loops. Both loops may be active, but only one of these ports may be receiving or originating transfers at any one time.

Do not connect both ports to the same loop.

For drives connected to two loops. Port A and Port B must not be mixed on the same loop.

9.4 SCSI interface commands supported

Table 10 lists the SCSI interface commands that ST15150FC drives support.

Table 10: Supported commands

Command code	Supported	Command name
00h	Y	Test unit ready
01h	Y	Rezero unit
03h	Y	Request sense
	Y	Extended sense
	Y	Field pointer bytes
	Y	Actual retry count bytes
04h	Y	Format unit [1]
07h	Y	Reassign blocks
08h	Y	Read
0Ah	Y	Write
0Bh	Y	Seek
12h	Y	Inquiry
	Y	Vital product data page
	Y	Unit serial number page
	Y	Implemented operating def. page
	Y	Firmware numbers page
	Y	Date code page
	Y	Jumper settings page
15h	Y	Mode select (same pages as Mode Sense command shown below)
16h	N	Reserve [3]
17h	N	Release [3]

Table 10: Supported commands (Continued)

Command code	Supported	Command name
18h	N	Copy
1Ah	Y	Mode sense
	Y	Unit attention page (00h)
	Y	Error recovery page (01h)
	Y	Disconnect/reconnect control (page 02h)
	Y	Format page (03h)
	Y	Rigid disc drive geometry page (04h)
	Y	Verify error recovery page (07h)
	Y	Caching parameters page (08h)
	Y	Control mode page (0Ah)
	Y	Notch and partition page (0C) (media zones)
1Bh	Y	Start unit/stop unit
1Ch	Y	Receive diagnostic results
	Y	Supported diagnostics pages
	Y	Translate page
1Dh	Y	Send diagnostics page
	Y	Supported diagnostics pages
	Y	Translate page
25h	Y	Read capacity
28h	Y	Read extended
2Ah	Y	Write extended
2Bh	Y	Seek extended
2Eh	Y	Write and verify
2Fh	Y	Verify
30h	N	Search data high
31h	N	Search data equal
32h	N	Search data low
33h	N	Set limits
34h	N	Prefetch
35h	Y	Synchronize cache
36h	N	Lock-unlock-cache
37h	Y	Read defect data
39h	N	Compare
3Ah	N	Copy and verify
3Bh	Y	Write buffer
	Y	Firmware download option [2]
3Ch	Y	Read buffer
3Eh	Y	Read long
3Fh	Y	Write long
40h	N	Change definition
41h	N	Write same
42-4Bh	N	Not used
4Ch	N	Log select

Table 10: Supported commands (Continued)

Command code	Supported	Command name
4Dh	N	Log Sense
4E-54h	N	Not used
55h	Y	Mode Select (10)
56h	Y	Reserved (10)
	Y	3rd party reserve
	N	Extend reservation
57h	Y	Released (10)
58-59h	N	Not used
5Ah	Y	Mode Sense (10)
5B-5Fh	N	Not used
60-BFh	N	Not used
C0-DFh	N	Not used
EO-FFh	N	Not used

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

[2] **Warning.** Power loss during flash programming can result in firmware corruption. This usually makes the drive inoperable.

[3] The 6-byte Reserve and Release commands are not supported as they do not support the third-party address space required for Fibre Channel.

9.4.1 Inquiry data

Table 11 lists the Inquiry command data that the drive should return to the initiator per the format given in the *SCSI Interface Product Manual*.

Table 11: Barracuda 4FC inquiry data (ASA II)

Bytes	Data (hex)																
0-15	00	00	**	22	8F	00	PP	02	53	45	41	47	41	54	45	20	Vendor ID
16-31	53	54	[31	35	31	35	30	46	43]	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*	35*	20	53	65	61	67	61	74	65	20	41	6C	6C	20	notice
128-143	72	69	67	68	74	73	20	72	65	73	65	72	76	65	64	20	
144-147	D#	D#	D#	D#													

* Copyright year (changes with actual year).
** 02 = SCSI-2 implemented with some SCSI-3 features (default).
PP 20 = Inquiry data for an Inquiry command received on Port A.
30 = Inquiry data for an Inquiry command received on Port B.
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 00 00 00 00.
[ ] Bytes 18 through 24 reflect drive model.

9.4.2 Mode Sense data

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

Definitions:

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

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

Table 12: Mode Sense data, Barracuda 4FC default values (SCSI-1 implementation)

Bytes	**00**	**01**	**02**	**03**	**04**	**05**	**06**	**07**	**08**	**09**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
Mode Sense Header	9f	00	10	08																				
	00	7f	fe	db	00	00	02	00																
<---------- Mode sense pages data ---------->																								
DEF	81	0a	04	20	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	ff	ff	00	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	20	30	00	00	00	00	00	ff	ff												
CHG	87	0a	0f	ff	00	00	00	00	00	00	00	00												
DEF	88	12	14	00	ff	ff	00	00	00	9f	02	7c	80	03	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	11	00	00	00	00	00	00	00	00												
DEF	8c	16	80	00	00	1d	00	00	00	00	00	00	00	0e	7e	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	80	02	00	00																				
CHG	80	02	36	80																				
	<--- Read capacity data --->																							
	7f	fe	da	00	00	02	00																	

9.5 Miscellaneous operating features and conditions

Table 13 lists various features and conditions. A “Y” in the support column indicates the feature or condition is supported on ST15150FC drives. An “N” in the support column indicates the feature or condition is not supported.

Table 13: Miscellaneous features

Supported	Feature or condition
Y	FC-AL selective reset
Y	Automatic contingent allegiance
N	Asynchronous event notification
Y	Synchronized (locked) spindle operation
Y	Segmented caching
N	Zero latency read
Y	Queue tagging (up to 64 que tags supported)
Y	Deferred error handling
Y	Parameter rounding (controlled by round bit in Mode Select page 0)
Y	Reporting actual retry count in Extended Sense bytes 15, 16, and 17
N	Adaptive caching
Y	SMP = 1 in Mode Select command needed to save RPL and rotational offset bytes (in Table 5.2.1-25 in the *SCSI-2 Interface Product Manual*)

Table 14: Miscellaneous status

Supported	Status
Y	Good
Y	Check condition
Y	Condition met/good
Y	Busy
Y	Intermediate/good
Y	Intermediate/condition met/good
Y	Reservation conflict
Y	Task set full
Y	ACA active
Y	ACA active, faulted initiator

9.6 FC-AL physical interface

Figure 13 shows the location of the Fibre Channel single connection attachment (FC-SCA) on ST15150FC drives. Figure 15 provides the dimensions of the FC-SCA.

Details of the physical, electrical, and logical characteristics are provided within this section. The operational aspects of Seagate's Fibre Channel drives are provided in the *Fibre Channel Arbitrated Loop Interface Product Manual*.

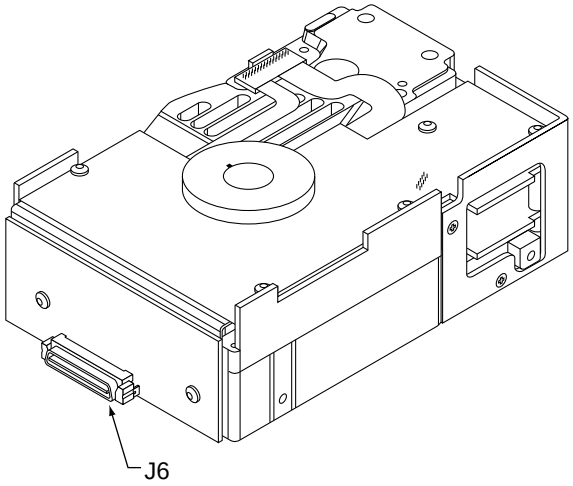


Figure 13. ST15150FC physical interface

9.6.1 Physical characteristics

This section defines physical interface connector and its functions on a loop.

9.6.1.1 Physical description

ST15150FC drives may be connected in a loop together or with other compatible FC-AL devices. A maximum of 127 devices may have addresses; however, one of the addresses is reserved for a fabric port switch device. This means 126 addresses are available for FC-AL devices. More FC-AL compatible devices may physically reside on the loop, but they will not be functional because they would not be able to obtain valid addresses.

Port bypass circuits (PBCs) allow devices to be inserted into unpopulated locations or removed from the loop with loop operation recovery after a brief disruption. These PBCs are located external to the FC-AL device. Figure 14 shows the relationship between the PBC and FC-AL device.

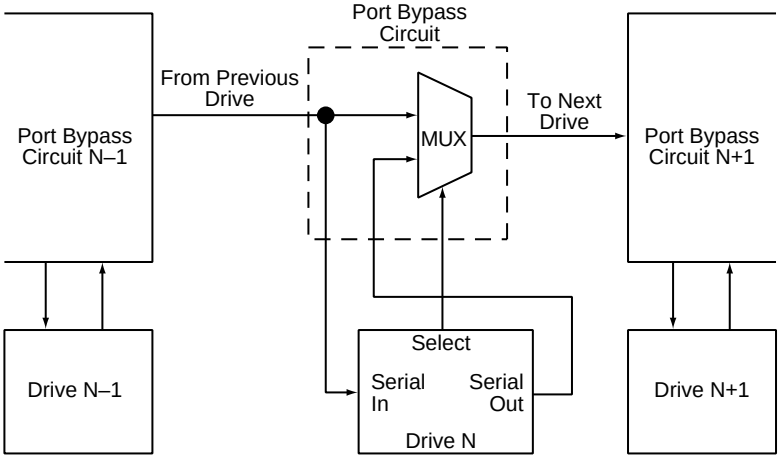


Figure 14. Port bypass circuit physical interconnect

9.6.2 Connector requirements

Recommended mating SCA part numbers:

Part description	Positions	Part number	Features
AMP Vertical (SCA sequence)	40	787317-1	With polarization
AMP Vertical (SCA sequence)	40	557103-5	Without polarization

The FC-AL SCA device connector is illustrated in Figure 15 below.

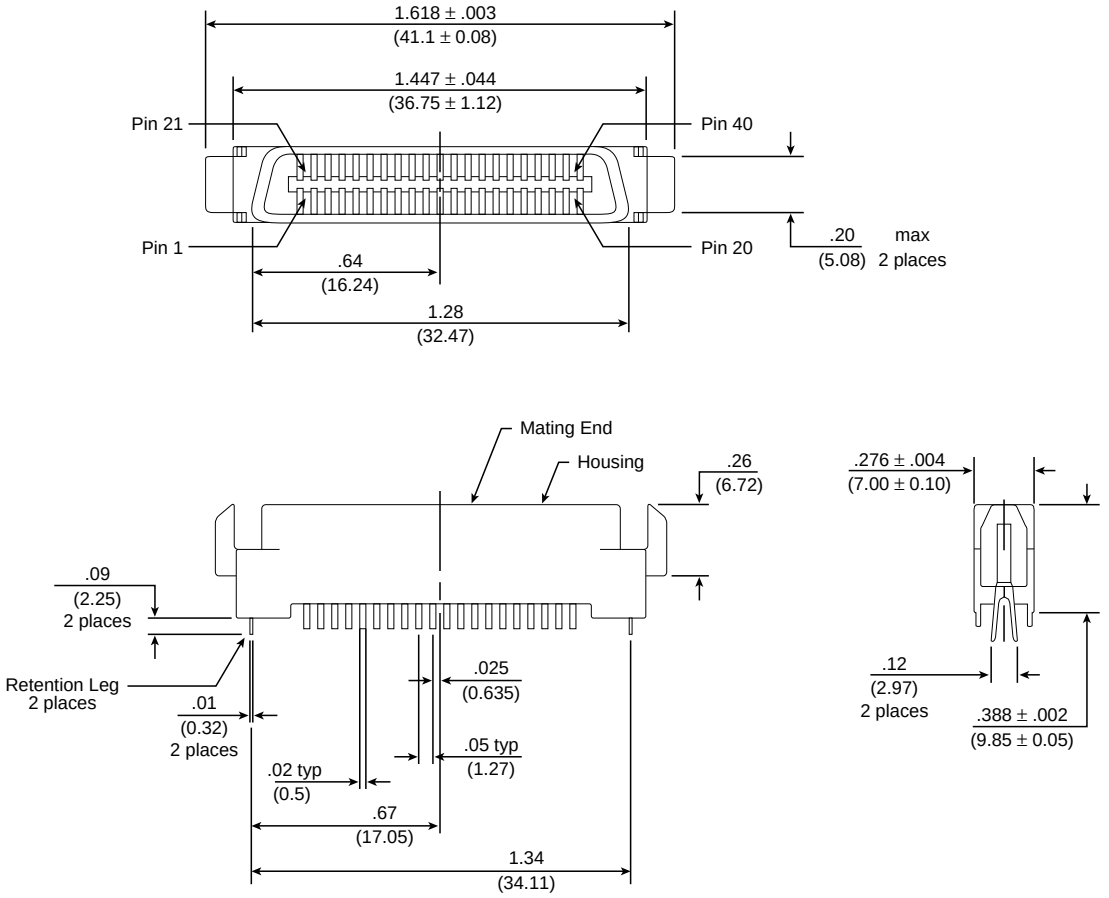


Figure 15. FC-AL SCA device connector

9.6.3 Electrical description

ST15150FC drives use the FC-SCA connector for:

- DC power
- FC-AL interface
- Drive select (device identification)
- Option selection

This 40-pin connector is designed to plug directly into a backpanel. External cables are not required.

9.6.4 Pin descriptions

This section provides a pin-out of the FC-SCA and a description of the functions provided by the pins.

Table 15: FC-SCA pin descriptions

Connector contact	Signal name	Signal type
1*	-EN bypass port A	TTL output
2*	12 Volts	
3*	12 Volts	
4*	12 Volts	
5*	Reserved NC	
6*	Reserved NC	
7*	Active LED out	Open collector out
8*	Spindle sync	Bi direct [1]
9*	Start_1	TTL input
10*	Start_2	TTL input
11*	-EN bypass port B	TTL output
12*	SEL_6	TTL input
13*	SEL_5	TTL input
14*	SEL_4	TTL input
15*	SEL_3	TTL input
16*	Fault LED out	Open collector out
17*	Reserved NC	
18*	Reserved NC	
19*	5 Volts	
20*	5 Volts	

Connector contact	Signal name	Signal type
21	12 Volts charge	
22	Ground	
23	Ground	
24*	+Port A_in	Diff. PECL input pair
25*	-Port A_in	
26	Ground	
27*	+Port B_in	Diff. PECL input pair
28*	-Port B_in	
29	Ground	
30*	+Port A_out	Diff. PECL output pair
31*	-Port A_out	
32	Ground	
33*	+Port B_out	Diff. PECL output pair
34*	-Port B_out	
35	Ground	
36	SEL_2	TTL input
37	SEL_1	TTL input
38	SEL_0	TTL input
39	Reserved NC	
40	5 Volts charge	

*Short pins in mating backpanel connector.

[1] See Section 4.7, “Synchronized spindle operation” for electrical characteristics.

9.6.4.1 FC-AL transmitters and receivers

A typical FC-AL differential copper transmitter and receiver pair is shown in Figure 16. The receiver is required to provide the AC coupling to eliminate ground shift noise.

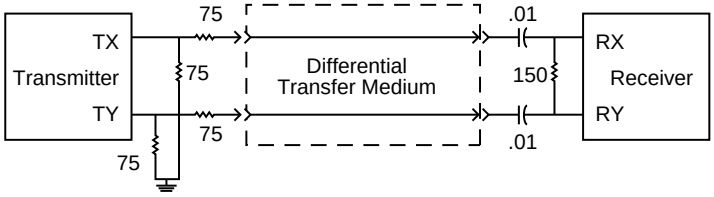


Figure 16. FC-AL transmitters and receivers

9.6.4.2 Power

Power is supplied through the FC-SCA with support for +5 volts and +12 volts. All of the voltage pins in the drive connector are the same length.

Four 12 volt pins provide +12 volt power to the drive. The current return for the +12 volt power supply is through the common ground pins. The supply current and return current must be distributed as evenly as possible among the pins. The maximum current typically occurs while the drive motor is starting.

Three 5 volt pins provide logic power to the drive. The current return for the +5 volt power supply is through the common ground pins. The supply and return current must be distributed as evenly as possible among the voltage and ground pins.

The mating connector pins use shorter contacts to achieve power surge reductions and to aid in “hot plugging” the drives. There are longer voltage contacts in the connector to enable the drive filter capacitors to charge. Current to the drive through the long charge pins is limited by the system in which the drive operates. Three of the +12 volt pins are shorter to allow capacitive pre-charging through the longer +12 volt charge pin. Two of the +5 volt pins are shorter to allow capacitive precharging through the longer +5 volt charge pin.

9.6.4.3 Fault LED out

The Fault LED Out signal is driven by the drive when:

- the drive detects failure of both ports
- the drive detects an internal disc failure
- the drive receives the appropriate fault LED command from the host

The Fault LED Out signal is designed to pull down the cathode of an LED. The anode is attached to the proper +5 voltage supply through an appropriate current-limiting resistor. The LED and the current-limiting resistor are external to the drive.

9.6.5 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. See Section 4.7.

9.6.5.1 Electrical description of the SSI

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 3.

9.6.5.1.1 Drivers and Receivers

Figure 17 shows a diagram of the driver/receiver circuit. The ST15150FC uses J6 pin 8 for spindle sync reference. The driver circuits have the following electrical specifications.

Negated (false): 0.0 V to +0.4 V @ I = - 24 mA (max)

Asserted (true): +2.24V to +5.25V @ I = +250µA

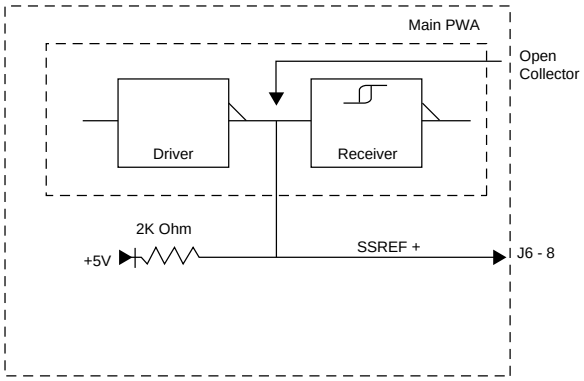


Figure 17. SCSI reference index signal driver/receiver combination

9.6.5.1.2 Termination

The reference index signal (SSREF+) is terminated with a 2.21 K ohm resistor. Each drive has a termination resistor located on the Main PCB. The terminator resistor is not removable and is always in the circuit. Back-feeding of current is prevented by a diode.

9.6.5.2 Active LED Out

The Active LED Out signal is driven by the drive as indicated in Table 16.

Table 16: Active LED out conditions

Normal command activity	LED status
Spun down and no activity	Off
Spun down and activity (command executing)	On
Spun up and no activity	On
Spun up and activity (command executing)	Off
Spinning up or down	Blinks steadily
Format in progress, each cylinder change	Toggles on/off

The Active LED Out signal is designed to pull down the cathode of an LED. The anode is attached to the proper +5 voltage supply through an appropriate current limiting resistor. The LED and the current limiting resistor are external to the drive.

9.6.5.3 – Enable Bypass Signal Port A - Port B

The – Enable Bypass Port A (– EN BYP Port A) and – Enable Bypass Port B (– EN BYP Port B) control the port bypass circuits (PBC) located external to the disc drive. The PBC allows a loop to remain functional in the event of a drive failure or removal. When these signals are active, low, the PBC bypasses the drive on the associated port. When an Enable Bypass signal is active, the corresponding Port Bypass LED signal in connector J20 is driven low by the disc drive. A pull down resistor, 1K, located with the PBC on the system back panel should be used to insure the bypass is enabled if the disc drive is not installed.

The Enable Bypass signal is active under failing conditions within the drive, on detection of the Loop Port Bypass primitive sequence, or on removal of the disc. In the bypass state the disc continues to receive on the inbound fibre. Enable Bypass may be deactivated by detection of a Loop Port Enable primitive sequence if the drive has completed self-test and a hardware failure is not present.

Failure modes detected by the disc drive that will enable bypass include:

- Transmitter/ receiver wrap test failure
- Loss of receive clock
- Loss of transmission clock
- Drive interface hardware error

9.6.5.4 Motor start controls

The drive's motor is started according to the Start_1 and Start_2 signals described in Table 17. The state of these signals can be wired into the backplane socket or driven by logic on the backplane.

Table 17: Motor start control signals

Case	Start_2	Start_1	Motor spin function
1	Low	Low	Motor spins up at DC power on.
2	High	Low	Motor spins up only when SCSI Start command is received.
3	Low	High	Motor spins up after a delay of 12 seconds (max) times the module 8 value of the numeric SEL ID of the drive from DC power on.
4	High	High	The drive will not spin up.

9.6.5.5 SEL ID lines

The SEL_6 through SEL_0 ID lines provide a binary decode associated with a physical unit for the full addressable logic range and beyond of the FC-AL. Refer to Table 18 for the SEL to FC-AL physical addresses (AL-PA). You can think of the SEL lines as the equivalent of a backpanel logic plug. The drive does not provide pull up resistors on these lines. The backpanel is required to provide high and low inputs to the SEL-ID lines as described in Section 9.7.1.

SEL setting 7F hex maps to a valid AL-PA. This value signals to the drive that physical addresses are not being assigned through the SEL lines and that a “soft” address is being assigned using the FC-AL initialization sequence.

Table 18 provides the AL-PA values for each SEL value. The first entry in the table is switch SEL_ID = 00. The last entry is switch SEL_ID = 7D. Switch SEL_ID value 7E is AL-PA 00 which is not valid for a NL_Port and is therefore not lincluded in the table.

Table 18: Arbitrated loop physical address (AL_PA) values

AL_PA (hex)	SEL ID (hex)	Setting (dec)
EF	00	00
E8	01	01
E4	02	02
E2	03	03
E1	04	04
E0	05	05
DC	06	06
DA	07	07
D9	08	08
D6	09	09
D5	0A	10
D4	0B	11
D3	0C	12
D2	0D	13
D1	0E	14
CE	0F	15
CD	10	16
CC	11	17
CB	12	18
CA	13	19
C9	14	20
C7	15	21
C6	16	22
C5	17	23
C3	18	24
BC	19	25
BA	1A	26
B9	1B	27
B6	1C	28
B5	1D	29
B4	1E	30
B3	1F	31
B2	20	32
B1	21	33
AE	22	34
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AC	24	36
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A3	2B	43
9F	2C	44
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9D	2E	46
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9.7 Signal characteristics

This section describes the electrical signal characteristics of the input and output signal of ST15150FC drives. Refer to Table 15 on page 43 for signal type and signal name information.

9.7.1 TTL input characteristics

Table 19 provides the TTL input characteristics.

Table 19: TTL input characteristics

State	Voltage	Current
High	$2.4 < V_{IH} < 5.5V$	$0 < I_{IH} < \pm 100\mu A$
Low	$-0.5V < V_{IL} < 0.4V$	$0 < I_{OH} < -3$ mA

9.7.2 LED driver signals

Fault and Active LED signals are located in the FC-SCA connector (J6). Refer to Table 20 for the output characteristics of the Fault LED drive signal. Refer to Table 21 for the characteristics of the Active LED drive signal.

Table 20: Fault LED drive signal

State	Current drive available	Output voltage
LED off, high	$0 < I_{OH} < 100\mu A$	
LED on, low	$I_{OL} < -30$ mA	$0 < V_{OL} < 0.8V$

Table 21: Active LED drive signal

State	Current drive available	Output voltage
LED off, high	$0 < I_{OH} < 100\mu A$	
LED on, low	$I_{OL} < -10$ mA	$0 < V_{OL} < 0.8V$

9.7.3 Low drive LED signals

The signals listed in Table 22 are located in the indicator connector (J20) on the front of the drive..

Table 22: Low drive open collector output characteristics of LED driver signal (indicator connector only)

State	Current drive available	Output voltage
LED off, high	$0 < I_{OH} < 100\mu A$	
LED on, low	$I_{OL} < -2$ mA	$0 < V_{OL} < 0.8V$

9.7.4 Differential PECL output

The serial PECL output signal voltage characteristics are provided in Table 23.

Table 23: Differential PECL output characteristics

Description	Parameter	Notes
Serial output voltage swing	$300 < V_{out} < 650$ mV	Centered at 1.32V

Figure 18 provides the data output valid eye diagram relative to the bit cell time.

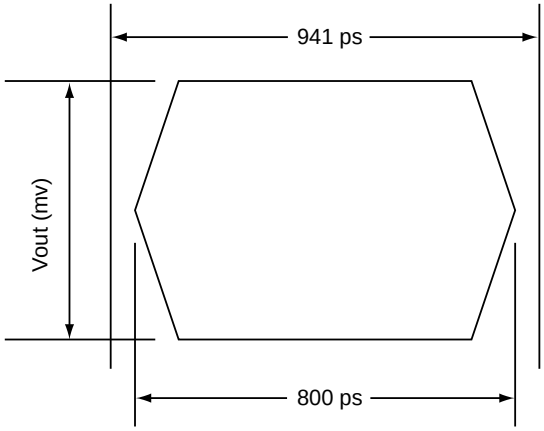

Figure 18. Transmit eye diagram

9.7.5 Differential PECL input

The serial PECL input signal voltage characteristics are provided in Table 24.

Table 24: Differential PECL input characteristics

Description	Parameter	Notes
Serial input voltage swing	200 < V_{in} < 1,300 mV	AC coupled

Figure 19 provides the data valid eye diagram for typical and minimum requirements to recover data at the specified interface error rate.

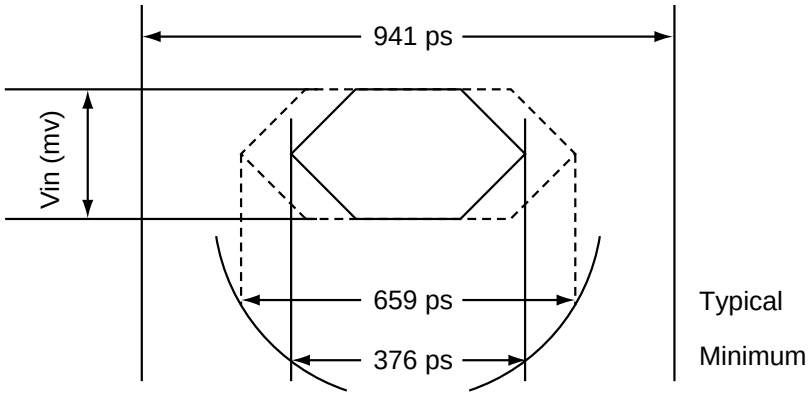

Figure 19. Receive eye diagram

10.0 Technical support services

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France	33-1-40-67-1034
Germany	49-89-140-9331
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