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Cheetah 4LP FC Disc Drive
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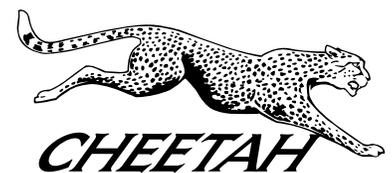
ST34501FC
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Product Manual, Volume 1
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1.0 Scope

This manual describes Seagate® Cheetah™ 4LP FC (Fibre Channel) disc drives.

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

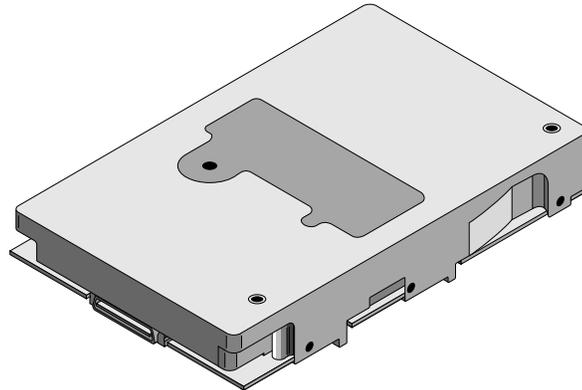


Figure 1. Cheetah 4LP FC family disc drive

2.0 Applicable standards and reference documentation

The drive has been developed as a system peripheral to the highest standards of design and construction. The drive depends upon its host equipment to provide adequate power and environment in order to achieve optimum performance and compliance with applicable industry and governmental regulations. Special attention must be given in the areas of safety, power distribution, shielding, audible noise control, and temperature regulation. In particular, the drive must be securely mounted in order to guarantee the specified performance characteristics. Mounting by bottom holes must meet the requirements of Section 8.5.

2.1 Standards

The Cheetah 4LP FC family complies with Seagate standards as noted in the appropriate sections of this manual and the Seagate *Fibre Channel Interface Manual*, part number 77767496 (Vol. 2).

The Cheetah 4LP FC disc drive is a UL recognized component per UL1950, CSA certified to CSA C22.2 No. 950-M89, and VDE certified to VDE 0805 and EN60950.

2.1.1 Electromagnetic compatibility

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

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

2.1.1.1 Electromagnetic susceptibility

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

2.2 Electromagnetic compliance

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

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

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

Electromagnetic compliance for the European Union

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

Australian C-Tick

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

2.3 Reference documents

Cheetah 4LP FC Installation Guide

Seagate part number: 83329180

Fibre Channel Interface Manual

Seagate part number: 77767496

SCSI Interface Product Manual

Seagate part number: 77738479

ANSI Fibre Channel Documents

X3.230-1995 FC Physical and Signaling Interface (FC-PH)

X3.272-19946 FC Arbitrated Loop (FC-AL)

X3.269-1996 Fibre Channel Protocol for SCSI (FCP)

TR X3.XXX-199X Private Loop SCSI Direct Attach

ANSI Small Computer System Interface (SCSI) Documents

X3.131-1994 (SCSI-2)

X3.270-199X (SCSI-3) Architecture Model

SFF-8045 Specification for 40-pin SCA-2 Connector with Parallel Selection.

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

3.0 General description

Cheetah 4LP FC 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 Interface 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 (ST34501FC 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 frames, 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 2.3 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.

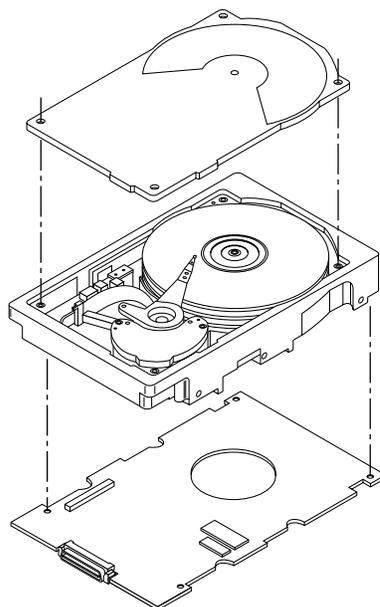


Figure 2. Cheetah 4LP FC disc drive

Cheetah 4LP FC 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.

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

3.1 Standard features

Cheetah 4LP FC 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
- Supports up to 16 initiators
- Downloadable firmware using the FC-AL interface
- Drive selection ID and configuration options are set on the FC-AL backpanel or through interface commands. Jumpers are not required on the drive.
- Fibre Channel worldwide name uniquely identifies the drive and each port
- User-selectable logical block size (180 to 4,096 bytes)
- Selectable frame sizes from 128 to 512 bytes
- Reallocation of defects on command (post format)
- Industry standard 3.5-inch low profile (1 inch high) form factor dimensions
- Programmable logical block reallocation scheme
- Flawed sector reallocation at format time
- Programmable autowrite and read reallocation
- Reed-Solomon error correction code for header and data fields
- Sealed head and disc assembly (HDA)
- No preventive maintenance or adjustments required
- Dedicated head landing zone
- Automatic shipping lock
- 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
- 1,024 Kbyte data buffer (see Section 4.5)
- Embedded servo design

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
- 10,033 RPM spindle; average latency = 2.99 msec
- Command queuing of up to 64 commands
- Background processing of queue
- Supports start and stop commands
- Adaptive seek velocity; improved seek performance

3.4 Reliability

- 1,000,000 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
- Self-Monitoring Analysis and Reporting Technology (S.M.A.R.T.)
- Dithering

3.5 Unformatted and formatted capacities

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

ST34501FC drives uses a regional sparing scheme. The drive is divided into regions that are each 12 cylinders wide. Each region has 108 spares when formatted with 512-byte logical blocks.

| | Formatted | Unformatted |
|-----------|------------------|--------------------|
| ST34501FC | 4.52 Gbytes | 5.59 Gbytes |

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 Interface Manual* (part number 77767496).

3.6 Factory-installed accessories

OEM standard drives are shipped with the Cheetah 4LP FC Installation Guide (part number 83329180).

3.7 Factory-installed options

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

- 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.

3.8 User-installed accessories

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

- Evaluation kit, part number 73473641.
This kit provides an adapter card ("T-card") to allow cable connections for two FC ports and DC power. Two twin axial cables, 6 feet in length, are included for the input and output connections to the FC interface.

4.0 Performance characteristics

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

4.1 Internal drive characteristics

| | | ST34501FC |
|------------------------------|------------------|---|
| Drive capacity | 5.59 | Gbytes (unformatted) |
| | 4.52 | Gbytes (formatted with 512-byte logical blocks) |
| Read/write data heads | 8 | |
| Bytes per track | 115,078 | Bytes (average, unformatted) |
| Bytes per surface | 751.0 | Mbytes (unformatted) |
| Cylinders/tracks per surface | 6,526 | Tracks (user accessible) |
| Tracks per inch | 6,932 | TPI |
| Peak bits per inch | 135,401 | BPI |
| Internal data rate | 122-177 | Mbits/sec (variable with zone) |
| Disc rotation speed | 10,033 ± 0.5% .. | rpm |
| Avg rotational latency | 2.99 | msec |

4.2 Seek performance characteristics

Refer to paragraph 9.5, "FC-AL physical interface" and to the *Fibre Channel Interface Manual* (part number 77767496) for additional timing details.

4.2.1 Access time

| | | Including controller overhead^{1, 2} (msec) | |
|--------------|------------------------|--|--------------|
| | | Read | Write |
| Average | Typical ^{3,4} | 7.7 | 8.7 |
| Single track | Typical ^{3,4} | 0.98 | 1.24 |
| Full stroke | Typical ^{3,4} | 18.2 | 19.2 |

1. Execution time measured from receipt of the FCP Command to arbitration for the FCP Response.
2. Assumes no errors and no sector has been relocated.
3. Typical access times are measured under nominal conditions of temperature, voltage, and horizontal orientation as measured on a representative sample of drives.
4. Access time = controller overhead + average seek time.
Access to data = controller overhead + average seek time + latency time.

4.2.2 Format command execution time for ≥ 512-byte sectors

| | | ST34501FC |
|--------------------------|------------|------------------|
| Maximum (with verify) | 60 minutes | |
| Maximum (without verify) | 36 minutes | |

4.2.3 General performance characteristics

| | ST34501FC |
|--|-----------------------|
| Minimum sector interleave | 1 to 1 |
| Data buffer to/from disc media (one 512-byte logical block)* | |
| Minimum | 15.25 MBytes/sec |
| Maximum | 22.125 MBytes/sec |
| Fibre Channel Interface maximum instantaneous transfer rate | 106.3 Mbytes/sec* |
| Logical block sizes | |
| Default is 512-byte data blocks | |
| Variable (180 to 736 bytes) in multiples of 4 bytes | |
| Variable (768 to 4,096 bytes) in multiples of 32 bytes | |
| Read/write consecutive sectors on a track | Yes |
| Overhead time for head switch in sequential mode | 0.798 msec |
| Overhead time for one track cylinder switch in sequential mode | <1.064 msec (typical) |
| Average rotational latency | 2.99 msec |

*Assumes no errors and no relocated logical blocks.

4.3 Start/stop time

If the Motor Start option is disabled, the drive becomes 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 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 *Fibre Channel Interface 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.

There is no power control switch on the drive.

4.4 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. Default is prefetch and read cache enabled.

If the Prefetch feature is enabled, data in contiguous logical blocks on the disc immediately beyond that which was requested by a Read command are retrieved and stored in the buffer for immediate transfer from the buffer to the host on subsequent Read commands that request those logical blocks (this is true even if cache operation is disabled). To enable Prefetch, use Mode Select page 08h, byte 12, bit 5 (Disable Read Ahead - DRA bit). DRA bit = 0 enables prefetch.

Since data that is prefetched replaces data already in some buffer segments, the host can limit the amount of prefetch data to optimize system performance. The Max Prefetch field (bytes 8 and 9) limits the amount of prefetch. The drive does not use the Prefetch Ceiling field (bytes 10 and 11).

4.5 Cache operation

Note. Refer to the *Fibre Channel Interface Manual* for more detail concerning the cache bits.

Of the 1,024 Kbytes physical buffer space in the drive, 967.5 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 Interface 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. If the cache is not enabled, 967.5 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.
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.

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

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

Each cache segment is actually a self-contained circular buffer whose length is an integer number of logical blocks. 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 967.5 Kbytes in the buffer by the number of segments to get the segment size. Default is 3 segments.

4.5.1 Caching write data

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

Write caching is enabled independently of read caching. Write caching is disabled by default on ST34501FC drives. 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.

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.

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 9.6.4, "Differential PECL input." |
| MTBF: | 1,000,000 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 FC-AL format commands.
- Errors caused by media defects or host system failures are excluded from error rate computations.

5.1.1 Environmental interference

When evaluating systems operation under conditions of electromagnetic interference (EMI), the performance of the drive within the system 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 detected from the error or fault status provided through the drive or FC-AL interface, or
- is not 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 ten recoverable seek errors in 10^8 physical seek operations. After detecting an initial seek error, the drive automatically reseek 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 (01h). If all three reseek fail, a seek positioning error (15h) is reported

with a Medium (03h) or Hardware error (04h) reported in the Sense Key. This is an unrecoverable seek error. Unrecoverable seek errors are classified as failures for MTBF calculations.

5.2 S.M.A.R.T.

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

Note. The drive's firmware will monitor specific attributes for degradation over time but can't predict instantaneous drive failures.

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

Controlling S.M.A.R.T.

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

You can measure off-line attributes and force the drive to save the data by using the RTZ command. Forcing S.M.A.R.T. resets the timer so that the next scheduled interrupt is in two hours.

You can interrogate the drive through the host to determine the time remaining before the next scheduled measurement and data logging process occurs. To accomplish this, issue a Log Sense command to log page 0x3E. This allows you to control when S.M.A.R.T. interruptions occur. Forcing S.M.A.R.T. with the RTZ command resets the timer.

Performance impact

S.M.A.R.T. attribute data is saved to the disc so that the events that caused a predictive failure can be recreated. The drive measures and saves parameters once every two hours subject to an idle period on the interface. The process of measuring off-line attribute data and saving data to the disc is uninterruptable. The maximum on-line only (DESCPT = 0; PERF = 1) processing delay is 50 ms. The maximum fully-enabled (DEXCPT = 0, PERF = 0) processing delay is 200 ms.

Reporting control

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

| Attribute | FRU code | Predictive failure description |
|------------------------|----------|--|
| LBA reassignment | 04 | LBA reassignment exceeding limits |
| Fly height | 31 | HDI errors exceeding limits |
| Read data errors | 32 | Read data errors exceeding limits |
| Recovered TAs | 37 | ERP TAs exceeding limits |
| Preamp detectable TAs | 38 | WUS TAs exceeding limits |
| Seek errors | 43 | Seek error rate exceeding limits |
| Track following errors | 45 | Servo settling errors exceeding limits |
| Spin-up errors | 5B | Spin-up retry count exceeding limits |
| General failure | EF | Missing SMART control information |

Determining rate

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

S.M.A.R.T. measures error rates. All errors for each monitored attribute are recorded. A counter keeps track of the number of errors for the current interval. This counter is referred to as the Failure Counter.

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

Predictive failures

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

5.3 Reliability and service

The reliability of Cheetah 4LP FC 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 you can use to enhance the service life of the drive.

5.3.1 Mean time between failure (MTBF)

The production disc drive achieves an MTBF of 1,000,000 hours when operated in an average local disc drive ambient temperature of 86°F (30°C) or less. Short-term excursions up to the specification limits of the operating environment will not affect MTBF performance. Operating the drive at ambient temperatures above these values may adversely affect the drive's ability to meet specifications. See Section 6.4, "Environmental limits" on page 18.

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.

5.3.2 Preventive maintenance

No routine scheduled preventive maintenance is required.

5.3.3 Service life

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

5.3.4 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 Seagate 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. The drive warranty is voided if the HDA is opened.

5.3.5 Service tools

No special tools are required for site installation or recommended for site 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.

5.3.6 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) 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.

The remaining warranty for a particular drive can be determined by calling Seagate Customer Service at 1-800-468-3472. The drive serial number is required to determine remaining warranty information.

Shipping

When transporting or shipping a drive, use only a Seagate approved container. Keep your original box. Seagate approved containers 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.

5.3.7 Hot plugging the drive

Inserting and removing the drive on the FC-AL will interrupt loop operation. The interruption 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 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 Initializing 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.

Caution. The drive motor must come to a complete stop prior to changing the plane of operation. This time is required to insure data integrity.

6.0 Physical/electrical specifications

This section provides information relating to the physical and electrical characteristics of the drive.

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] | ST34501FC | |
|-----------------------------|-----------|----------------------|--------------------------------------|
| | | +5V ±5% (Amps) | +12V ±5% ^[2] (Amps) |
| Avg idle current | [1] [8] | 1.000 | 0.874 |
| Max start current (peak DC) | [3] [6] | 1.074 | 2.239 |
| Delayed motor start (max) | [1] [4] | 0.634 | 0.177 |
| Operating current: | [7] | | |
| Typical | [1] [6] | 1.036 | 1.028 |
| Maximum | [1] | 1.083 | 1.075 |
| Max (peak) | | 1.239 | 2.196 |

- [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 10,033 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 3.
- [4] This condition occurs when the Motor Start option is enabled and the drive has not yet received a Start Motor command.
- [5] See 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 2.0A, 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 0.108 seconds.
- [8] All power-saving features enabled.

General DC power requirement notes.

1. Minimum current loading for each supply voltage is not less than 4% 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 3 identifies the drive +12V current profile. The current during the various times is as shown.

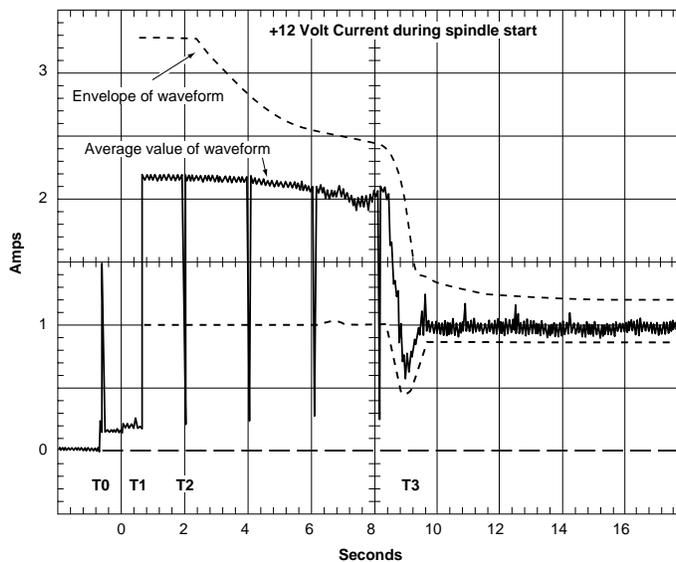


Figure 3. Typical Cheetah 4LP FC drive +12V current profile

- 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 Spindle is up to speed and the Head-Arm restraint is unlocked.

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

6.3 Power dissipation

Typical seek and read power dissipation is 18.3 watts (63.0 BTUs per hour) of DC power average at nominal voltages. Typical power dissipation under idle conditions is 15.5 watts (53 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 (1,000,000 hours) is based on operating at a local ambient temperature of 77°F (25°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 8 and 9 are not exceeded. Air flow may be needed to achieve these temperature values. Continual or sustained operation at case temperatures above these values will degrade MTBF.

The drive meets all specifications over a 41°F to 113°F (5°C to 45°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 with a maximum gradient of 10% per hour.

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 a vertical or horizontal position.

6.4.4.1 Shock

a. Operating (normal)

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

b. Operating (abnormal)

Equipment as installed for normal operation will 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 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 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 msec (half sinewave) will not exhibit device damage or performance degradation. Shock may be applied in the X, Y, or Z axis.

The drive subjected to non-repetitive shock not exceeding 140 Gs at a maximum of 2 msec (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 will 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 will operate error free while subjected to continuous vibration not exceeding:

5–350 Hz @ 0.5 G

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

b. Operating (abnormal)

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

15 minutes of duration at major resonant frequency

5–350 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 on 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 will 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.

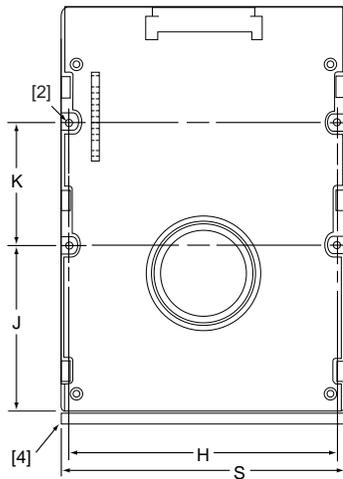
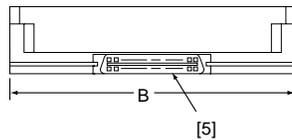
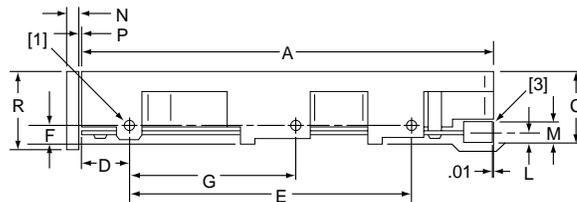
6.5 Electromagnetic susceptibility

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 4 for detailed mounting configuration dimensions for the drive. Refer to Figure 12 for detailed FC-AL SCA connector dimensions. A minimum clearance of 0.050 in. (1.27 mm) must be maintained from the PWA side of the drive.

| | | |
|--------|---------|-----------------|
| Height | 1.00 in | 25.4 mm |
| Width | 4.00 in | 101.6 mm |
| Depth | 5.75 in | 146.05 mm |
| Weight | 1.3 lb | 0.588 kilograms |



Notes:

- [1] Mounting holes three on each side, 6-32 UNC. Max screw length into side of drive 0.15 in. (3.81 mm). Screw tightening torque 6.0 in-lb (.675 NM) max with minimum thread engagement of 0.12 in. (3.05 mm).
- [2] Mounting holes four on bottom, 6-32 UNC. Max screw length into bottom of drive 0.15 in. (3.81 mm). Screw tightening torque 6.0 in-lb (.675 NM) max with minimum thread engagement of 0.12 in. (3.05 mm).
- [3] Power and interface connectors can extend past the "A" dimension by 0.040 in. (1.02 mm).
- [4] Decorative front panel.
- [5] Connector is centered on module ± 0.020 in. (.508 mm).

| | Inches | Millimeters |
|---|--------------------------|------------------|
| A | 5.750 \pm 0.010 | 146.05 \pm .25 |
| B | 4.000 \pm 0.010 | 101.60 \pm .25 |
| C | 1.000 + 0.026 - 0.010 | 25.40 \pm .38 |
| D | 0.625 \pm 0.020 | 15.87 \pm .50 |
| E | 4.000 \pm 0.005 | 101.60 \pm .13 |
| F | 0.250 \pm 0.005 | 6.35 \pm .13 |
| G | 2.375 \pm 0.010 | 60.32 \pm .25 |
| H | 3.750 \pm 0.010 | 95.25 \pm .25 |
| J | 2.370 \pm 0.010 | 60.20 \pm .25 |
| K | 1.750 \pm 0.020 | 44.45 \pm .50 |
| L | 0.181 \pm 0.015 | 4.32 \pm .38 |
| M | 0.275 \pm 0.015 | 7.00 \pm .38 |
| N | 0.190 \pm 0.010 | 4.83 \pm .25 |
| P | 0.049 max | 1.25 max |
| R | 1.000 \pm 0.010 | 25.40 \pm .25 |
| S | 4.000 \pm 0.010 | 101.60 \pm .25 |

Figure 4. 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 Interface 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 Interface Manual*. Also, more information on the drive Error Recovery philosophy is presented in the *Fibre Channel Interface Manual*.

8.0 Installation

Cheetah 4LP FC 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 9.5 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). 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 Fibre Channel 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 logical blocks. You need to reformat the drive only if you want to select a different logical block size or if you select a different spare logical block allocation scheme.

8.1 Drive ID/option selection

All drive options are made through the interface connector (J1). Table 15 provides the pin descriptions for the 40-pin Fibre Channel single connector (J1).

8.2 LED connections

A connector, J6, is provided on the printed circuit board (PCB) to provide port bypass, drive active, and drive fault LED connections (see Figure 6). Refer to Sections 9.5.7, 9.5.8, and 9.5.9 for descriptions of LED functions.

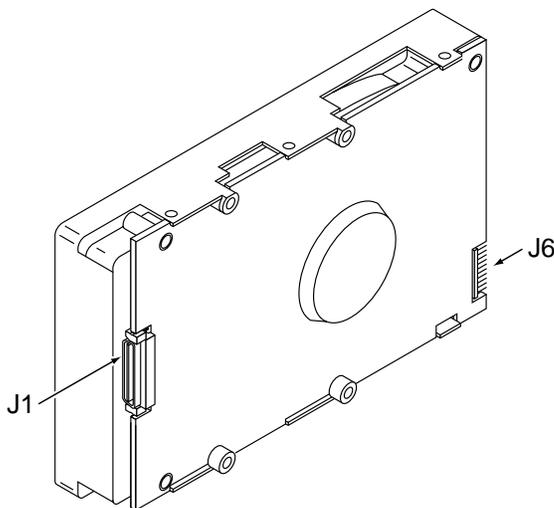
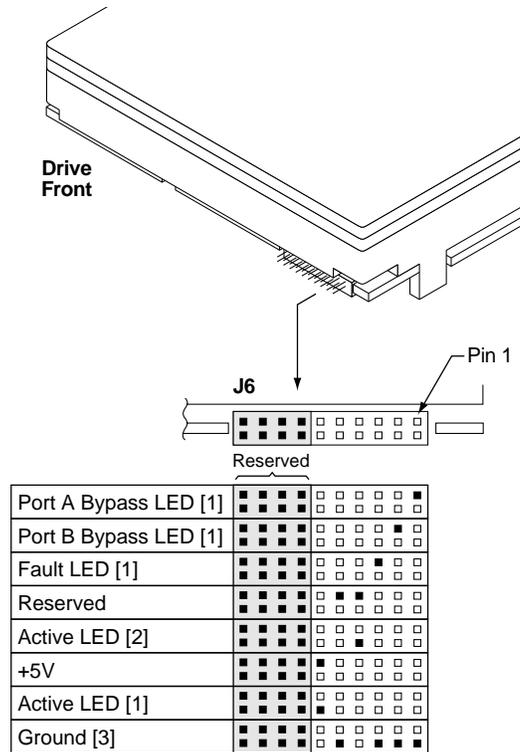


Figure 5. Physical interface



- [1] The drive has a 2.2K ohm resistor in series with this LED driver. Tie the minus side of an external high-efficiency LED (i.e., 2ma) to this pin. Connect the plus side of the LED to +5V.
- [2] An external current-limiting resistor is required when connecting an LED to this pin. The minus side of the resistor/LED combination is connected to this pin. Connect the plus side to +5V. This pin is connected in parallel with the signal of the same name in the interface connector (J1). The total current through both connectors is specified in Section 9.6 on page 47.
- [3] Jumper storage location (across pins 2 and 4).

Figure 6. LED indicator connector

8.2.1 J6 connector requirements

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

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 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 7. 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.

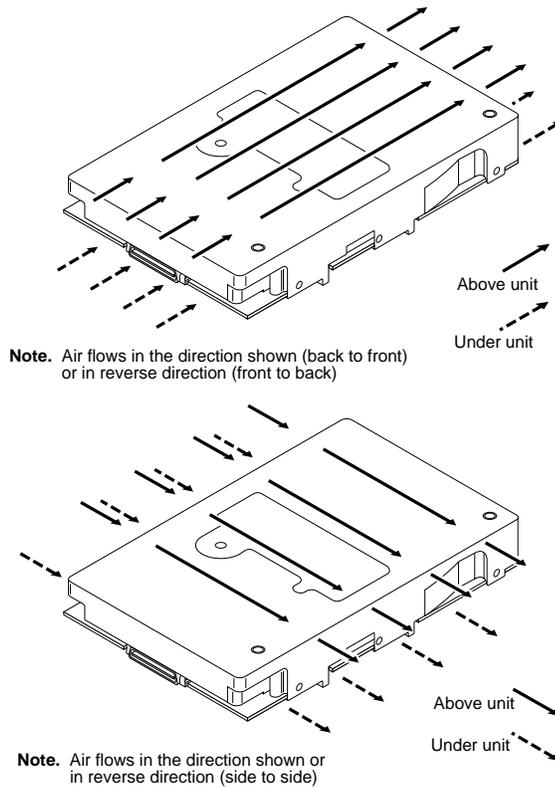


Figure 7. Air flow

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. The typical ambient air temperature associated with the list is 25°C, resulting in a MTBF of 1,000,000 hours.

PCB and HDA temperatures

| Card | Component | Reference | MTBF 1,000,000 hours at 30°C case temperature (°C) |
|------|---------------|-----------|---|
| | HDA | Figure 9 | 45 |
| GAAJ | OP Amp | 1 | 48 |
| GAAJ | Servo Control | 2 | 50 |
| GAAJ | Motor Control | 3 | 52 |
| GAAJ | Transceiver | 4 | 56 |

To obtain the maximum temperature for each of the reference components listed, add 20°C to the 1,000,000 hour MTBF case temperatures. The maximum allowable HDA case temperature is 60°C (see Figure 9). 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 maximum allowable HDA case temperature to meet the 1,000,000 hour MTBF is 45°C.

The air-flow pattern with which the temperature guidelines above were generated is shown in Figure 7. Local average air velocities were 0.92 m/sec (180 lfpm) and inlet air temperature to the drive was 25°C (77°F), plus a 5°C temperature rise in the test enclosure (30°C ambient local to the drive).

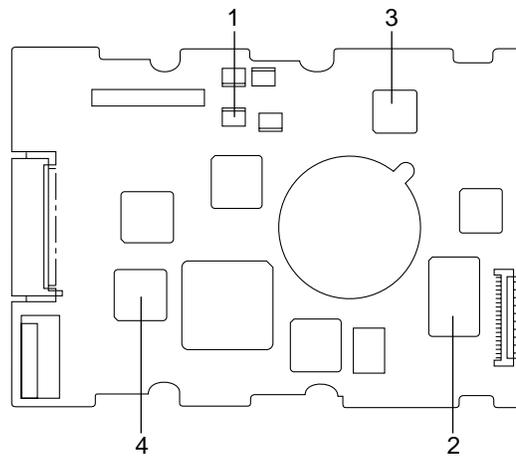


Figure 8. PCB temperature measurement locations

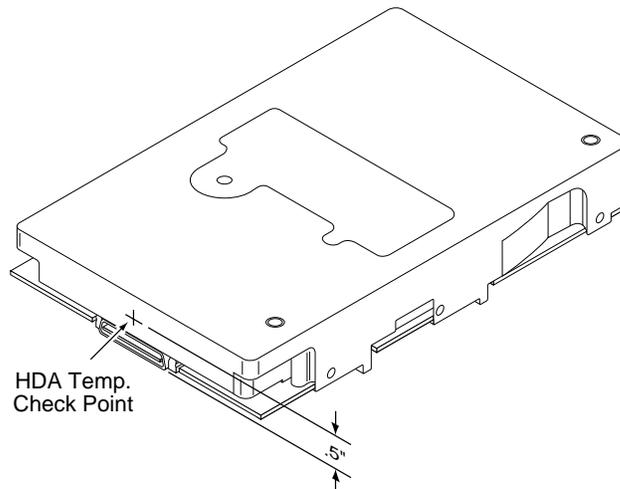


Figure 9. HDA case temperature measurement location

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:

$$k * x = F \leq 15 \text{ lb} = 67\text{N}$$

where k is the mounting surface stiffness (units in lb/in or N/mm) 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 deflection 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 drive and cannot be separated by the user. 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 ST34501FC drives. Additional information is provided in the *Fibre Channel Interface Manual* (part number 77767496).

9.1 FC-AL features

This section lists the Fibre Channel-specific features supported by ST34501FC drives.

9.1.1 Fibre Channel link service frames

Table 2 lists the link services supported by ST34501FC 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) Address Discovery (ADISC) Third-party Process Logout (TRPLO) |
| Extended link service reply frames | Accept (ACC) Link Service Reject (LS_RJT) |

9.1.2 Fibre Channel task management functions

Table 3 lists the Fibre Channel SCSI Fibre Channel Protocol (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 |

9.1.3 Fibre Channel task management responses

Table 4 lists the FC 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 |

9.1.4 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 | NN | NN | NN | NN | |
| 32-35 | NN | NN | NN | NN | | | | | | | | | | | | | |
| 36-47 | | | | | XX | Class 1 |
| 48-51 | XX | XX | XX | XX | | | | | | | | | | | | | |
| 52-63 | | | | | 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 | Reserved |
| 96-99 | XX | XX | XX | XX | | | | | | | | | | | | | |
| 100-111 | | | | | 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.

9.1.8 Fibre Channel Arbitrated Loop options

Table 9 lists the FC-AL options supported by ST34501FC 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 |

9.2 Dual port support

ST34501FC 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.

9.3 SCSI commands supported

Table 10 lists the SCSI commands that ST34501FC 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] |
| 18h | N | Copy |

Table 10: Supported commands (*continued*)

| Command code | Supported (<i>continued</i>) | Command name |
|--------------|--------------------------------|---|
| 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) |
| | Y | Power control page (1Ah) |
| | Y | Information exceptions control page (1Ch) |
| 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 |
| | Y | Disable page out |
| | Y | Force unit access |
| | N | Relative address |
| 2Ah | Y | Write extended |
| | Y | Disable page out |
| | Y | Force unit access |
| | N | Relative address |
| 2Bh | Y | Seek extended |
| 2Eh | Y | Write and verify |
| | Y | Disable page out |
| | Y | Byte check |
| | N | Relative address |
| 2Fh | Y | Verify |
| | Y | Disable page out |
| | Y | Byte check |
| | N | Relative address |
| 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 |

Table 10: Supported commands (*continued*)

| Command code | Supported (<i>continued</i>) | Command name |
|--------------|--------------------------------|---|
| 36h | N | Lock-unlock-cache |
| 37h | Y | Read defect data |
| 39h | N | Compare |
| 3Ah | N | Copy and verify |
| 3Bh | Y | Write buffer |
| | Y | Write combined header and data mode (0) |
| | Y | Write data mode (2) |
| | N | Download microcode mode (4) |
| | Y | Download microcode and save modes (5) |
| | N | Download microcode with offsets mode (6) |
| | Y | Download microcode with offsets and save mode (7) |
| | Y | Firmware download option [2] |
| 3Ch | Y | Read buffer |
| | Y | Read combined header and data mode (0) |
| | Y | Read data mode (2) |
| | Y | Read descriptor mode (3) |
| 3Eh | Y | Read long |
| 3Fh | Y | Write long |
| 40h | N | Change definition |
| 41h | N | Write same |
| 42-4Bh | N | Not used |
| 4Ch | Y | Log Select |
| 4Dh | Y | Log Sense |
| 4E-4Fh | N | Note used |
| 50h | N | XD Write |
| 51h | N | XP Write |
| 52h | N | XD Read |
| 53-54h | N | Not used |
| 55h | Y | Mode Select (10) [4] |
| 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) [4] |
| 5B-5Fh | N | Not used |
| 60-7Fh | N | Not used |
| 80h | N | XD Write Extended |
| 81h | N | Rebuild |
| 82-8Fh | N | Not Used |
| C0-DFh | N | Not used |
| EO-FFh | N | Not used |

- [1] Cheetah 4LP FC drives can format to any multiple of 4 bytes per logical block in the range 180 to 736 bytes and any multiple of 32 bytes per logical block in the range 768 to 4,096 bytes.
- [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 because they do not support the third-party address space required for Fibre Channel.
- [4] Reference Mode Sense command 1Ah for mode pages supported.

9.3.1 Inquiry data

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

Table 11: Cheetah 4LP FC inquiry data

| Bytes | Data (hex) | | | | | | | | | | | | | | | | |
|---------|------------|-----|-----|----|----|----|----|----|-----|----|----|----|----|----|----|-----|------------|
| 0-15 | 00 | 00 | ** | 22 | 8B | 00 | PP | 0A | 53 | 45 | 41 | 47 | 41 | 54 | 45 | 20 | Vendor ID |
| 16-31 | [53 | 54 | 33 | 34 | 35 | 30 | 31 | 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* | 37* | 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 16 through 24 reflect drive model.

9.3.2 Mode Sense data

The Mode Sense command provides a way for the drive to report its operating parameters to the initiator. The drive maintains four sets of mode parameters:

1. Default values

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

2. Saved values

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

When power is applied to the drive, it takes saved values from the media and stores them as current values in volatile memory. It is not possible to change the current values (or the saved values) with a Mode Select command before the drive achieves operating speed and is “ready.” An attempt to do so results in a “Check Condition” status.

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

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

3. Current values

Current values are volatile values being used by the drive to control its operation. A Mode Select command can be used to change the values identified as changeable values. Originally, current values are installed from saved or default values after a power on reset, hard reset, or Bus Device Reset message.

4. Changeable values

Changeable values form a bit mask, stored in nonvolatile memory, that dictates which of the current values and saved values can be changed by a Mode Select command. A one (1) indicates the value can be changed. A zero (0) indicates the value is not changeable. For example, in Table 12, refer to Mode page 81, in the row entitled "CHG." These are hex numbers representing the changeable values for Mode page 81. Note in columns 5 and 6 (bytes 04 and 05), there is 00h which indicates that in bytes 04 and 05 none of the bits are changeable. Note also that bytes 06, 07, 09, 10, and 11 are not changeable, because those fields are all zeros. In byte 02, hex value FF equates to the binary pattern 11111111. If there is a zero in any bit position in the field, it means that bit is not changeable. Since all of the bits in byte 02 are one's, all of these bits are changeable.

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

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

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

Definitions:

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

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

9.4 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. 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 |

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 |

9.5 FC-AL physical interface

Figure 10 shows the location of the J1 Fibre Channel single connection attachment (FC-SCA) and the J6 connector. Figure 12 provides the dimensions of the FC-SCA. Figure 13 provides the dimensions of the J6 connector.

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 Interface Manual*.

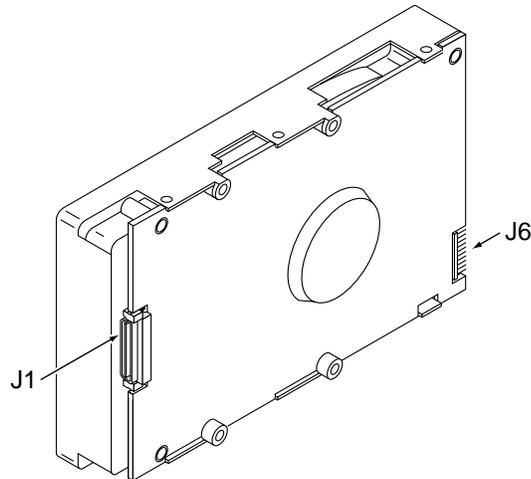


Figure 10. Physical interface

9.5.1 Physical characteristics

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

9.5.1.1 Physical description

Fibre Channel 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 interruption. These PBCs are located external to the FC-AL device. Figure 11 shows the relationship between the PBC and FC-AL device.

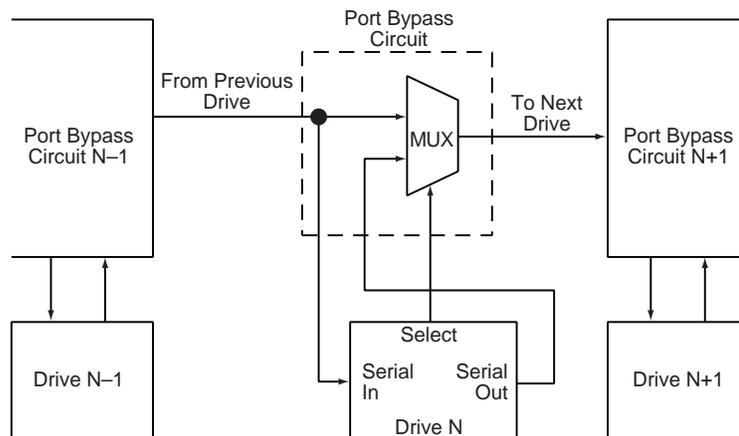


Figure 11. Port bypass circuit physical interconnect

9.5.2 Connector requirements

Recommended mating SCA part number:

| Part description | Positions | Part number | Features |
|-----------------------------|-----------|-------------|-------------------|
| AMP Vertical (SCA sequence) | 40 | 787317-1 | With polarization |

The FC-AL SCA device connector is illustrated in Figure 12. The J6 connector is illustrated in Figure 13.

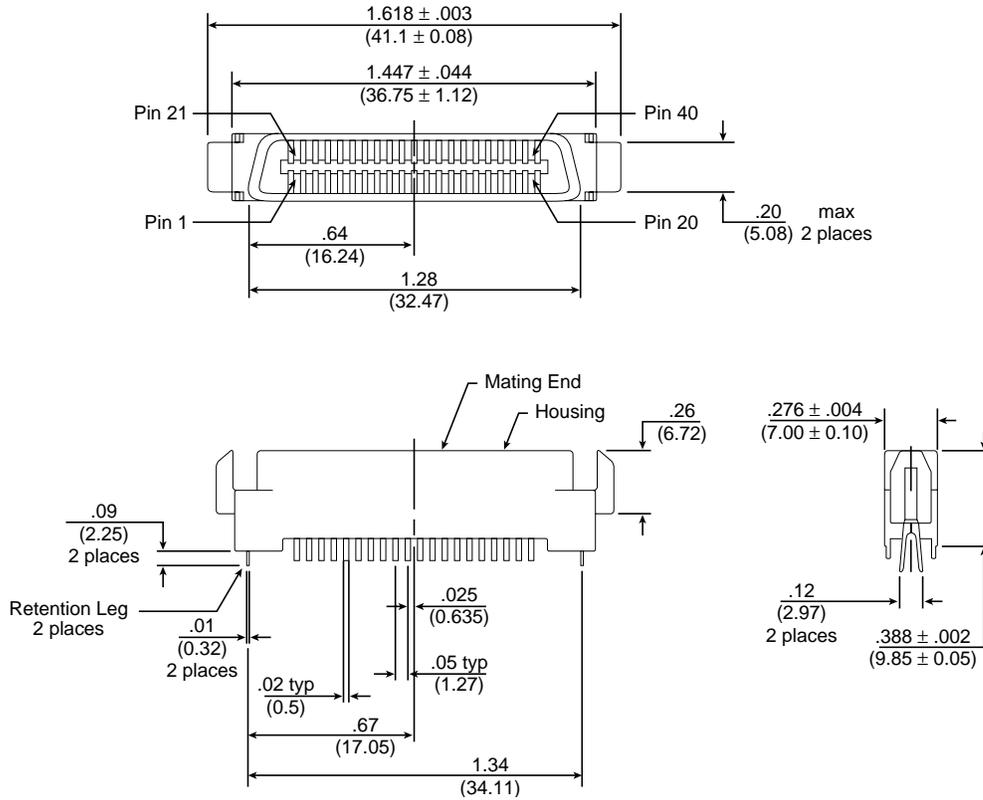


Figure 12. FC-AL SCA device connector dimensions

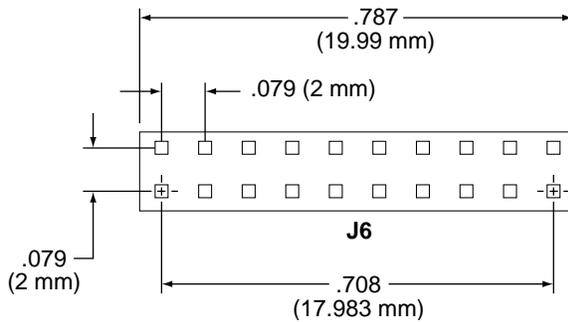


Figure 13. J6 connector dimensions

9.5.3 Electrical description

Fibre Channel 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.

9.5.4 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

| Pin | Signal name | Signal type | Pin | Signal name | Signal type |
|-----|-----------------------|--------------------|-----|-----------------|-----------------------|
| 1* | -EN bypass port A | TTL output | 21 | 12 Volts charge | |
| 2* | 12 Volts | | 22 | Ground | |
| 3* | 12 Volts | | 23 | Ground | |
| 4* | 12 Volts | | 24* | +Port A_in | Diff. PECL input pair |
| 5* | -Parallel ESI | TTL output | 25* | -Port A_in | |
| 6* | Ground (-DRV present) | | 26 | Ground | |
| 7* | Active LED out | Open collector out | 27* | +Port B_in | Diff. PECL input pair |
| 8* | Reserved | | 28* | -Port B_in | |
| 9* | Start_1 | TTL input | 29 | Ground | |
| 10* | Start_2 | TTL input | 30* | +Port A_out | Diff PECL output pair |
| 11* | -EN bypass port B | TTL output | 31* | -Port A_out | |
| 12* | SEL_6 | TTL input | 32 | Ground | |
| 13* | SEL_5 | TTL input | 33* | +Port B_out | Diff PECL output pair |
| 14* | SEL_4 | TTL input | 34* | -Port B_out | |
| 15* | SEL_3 | TTL input | 35 | Ground | |
| 16* | Fault LED out | Open collector out | 36 | SEL_2 | TTL input |
| 17* | Reserved NC | | 37 | SEL_1 | TTL input |
| 18* | Reserved NC | | 38 | SEL_0 | TTL input |
| 19* | 5 Volts | | 39 | Reserved NC | |
| 20* | 5 Volts | | 40 | 5 Volts charge | |

*Short pins in mating backpanel connector.

9.5.5 FC-AL transmitters and receivers

A typical FC-AL differential copper transmitter and receiver pair is shown in Figure 14. The receiver is required to provide the AC coupling to eliminate ground shift noise.

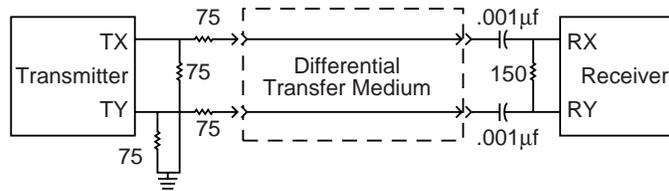


Figure 14. FC-AL transmitters and receivers

9.5.6 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.

9.5.7 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 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 volt supply through an appropriate current-limiting resistor. The LED and the current-limiting resistor are external to the drive.

9.5.8 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 volt supply through an appropriate current limiting resistor. The LED and the current limiting resistor are external to the drive.

9.5.9 – 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 drive. In the bypass state the drive 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

9.5.10 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. |

*This value may be reduced by drive suppliers to reflect the worst case time duration of peak current drains at the 12 Volt of 5 Volt source (or both) during motor spin up. The delay should never exceed 12 seconds.

9.5.11 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 9.6.1.

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 included in the table.

Table 18: Arbitrated loop physical address (AL_PA) values

| AL_PA (hex) | SEL ID (hex) | Setting (dec) | AL_PA (hex) | SEL ID (hex) | Setting (dec) | AL_PA (hex) | SEL ID (hex) | Setting (dec) |
|-------------|--------------|---------------|-------------|--------------|---------------|-------------|--------------|---------------|
| EF | 00 | 00 | A3 | 2B | 43 | 4D | 56 | 86 |
| E8 | 01 | 01 | 9F | 2C | 44 | 4C | 57 | 87 |
| E4 | 02 | 02 | 9E | 2D | 45 | 4B | 58 | 88 |
| E2 | 03 | 03 | 9D | 2E | 46 | 4A | 59 | 89 |
| E1 | 04 | 04 | 9B | 2F | 47 | 49 | 5A | 90 |
| E0 | 05 | 05 | 98 | 30 | 48 | 47 | 5B | 91 |
| DC | 06 | 06 | 97 | 31 | 49 | 46 | 5C | 92 |
| DA | 07 | 07 | 90 | 32 | 50 | 45 | 5D | 93 |
| D9 | 08 | 08 | 8F | 33 | 51 | 43 | 5E | 94 |
| D6 | 09 | 09 | 88 | 34 | 52 | 3c | 5F | 95 |
| D5 | 0A | 10 | 84 | 35 | 53 | 3A | 60 | 96 |
| D4 | 0B | 11 | 82 | 36 | 54 | 39 | 61 | 97 |
| D3 | 0C | 12 | 81 | 37 | 55 | 36 | 62 | 98 |
| D2 | 0D | 13 | 80 | 38 | 56 | 35 | 63 | 99 |
| D1 | 0E | 14 | 7C | 39 | 57 | 34 | 64 | 100 |
| CE | 0F | 15 | 7A | 3A | 58 | 33 | 65 | 101 |
| CD | 10 | 16 | 79 | 3B | 59 | 32 | 66 | 102 |
| CC | 11 | 17 | 76 | 3C | 60 | 31 | 67 | 103 |
| CB | 12 | 18 | 75 | 3D | 61 | 2E | 68 | 104 |
| CA | 13 | 19 | 74 | 3E | 62 | 2D | 69 | 105 |
| C9 | 14 | 20 | 73 | 3F | 63 | 2C | 6A | 106 |
| C7 | 15 | 21 | 72 | 40 | 64 | 2B | 6B | 107 |
| C6 | 16 | 22 | 71 | 41 | 65 | 2A | 6C | 108 |
| C5 | 17 | 23 | 6E | 42 | 66 | 29 | 6D | 109 |
| C3 | 18 | 24 | 6D | 43 | 67 | 27 | 6E | 110 |
| BC | 19 | 25 | 6C | 44 | 68 | 26 | 6F | 111 |
| BA | 1A | 26 | 6B | 45 | 69 | 25 | 70 | 112 |
| B9 | 1B | 27 | 6A | 46 | 70 | 23 | 71 | 113 |
| B6 | 1C | 28 | 69 | 47 | 71 | 1F | 72 | 114 |
| B5 | 1D | 29 | 67 | 48 | 72 | 1E | 73 | 115 |
| B4 | 1E | 30 | 66 | 49 | 73 | 1D | 74 | 116 |
| B3 | 1F | 31 | 65 | 4A | 74 | 1B | 75 | 117 |
| B2 | 20 | 32 | 63 | 4B | 75 | 18 | 76 | 118 |
| B1 | 21 | 33 | 5C | 4C | 76 | 17 | 77 | 119 |
| AE | 22 | 34 | 5A | 4D | 77 | 10 | 78 | 120 |
| AD | 23 | 35 | 59 | 4E | 78 | 0F | 79 | 121 |
| AC | 24 | 36 | 56 | 4F | 79 | 08 | 7A | 122 |
| AB | 25 | 37 | 55 | 50 | 80 | 04 | 7B | 123 |
| AA | 26 | 38 | 54 | 51 | 81 | 02 | 7C | 124 |
| A9 | 27 | 39 | 53 | 52 | 82 | 01 | 7D | 125 |
| A7 | 28 | 40 | 52 | 53 | 83 | | | |
| A6 | 29 | 41 | 51 | 54 | 84 | | | |
| A5 | 2A | 42 | 4E | 55 | 85 | | | |

9.6 Signal characteristics

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

9.6.1 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 | $-0.5V < V_{IL} < 0.4V$ | $0 < I_{OH} < -3 \text{ mA}$ |

9.6.2 LED driver signals

Fault and Active LED signals are located in the FC-SCA connector (J1) and through the indicator connector (J6). Refer to Table 20 for the output characteristics of the LED drive signals.

Table 20: LED drive signal

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

9.6.3 Differential PECL output

The serial PECL output signal voltage characteristics are provided in Table 21. The outputs are not AC coupled in order to deliver maximum signal without rise and fall time degradation. You must AC couple the receiver to isolate potentially different DC characteristics of the outputs and the receiver.

Table 21: Differential PECL output characteristics

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

Figure 15 provides the data output valid eye diagram relative to the bit cell time.

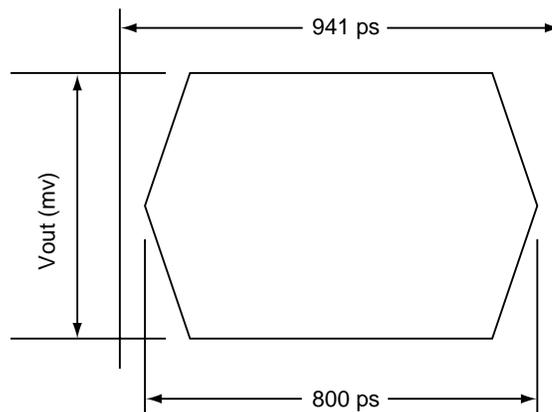


Figure 15. Transmit eye diagram

9.6.4 Differential PECL input

The serial PECL input signal voltage characteristics are provided in Table 22.

Table 22: Differential PECL input characteristics

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

Figure 16 provides the data valid eye diagram for typical and minimum requirements to recover data at the specified interface error rate.

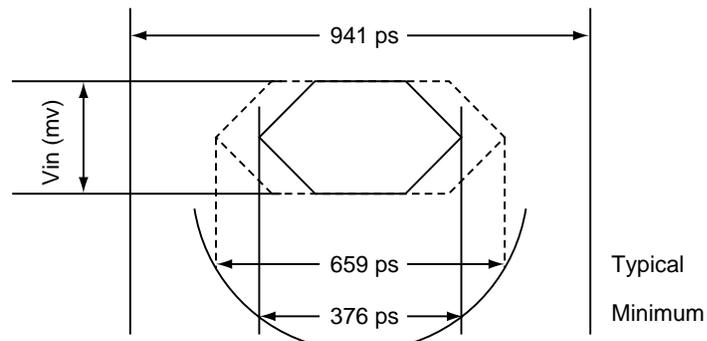


Figure 16. Receive eye diagram

10.0 Seagate technical support services

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

SeaFONE® 1-800-SEAGATE

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

Online services

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

SeaNET™

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

Seagate CompuServe forum

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

SeaBOARD®

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

| Location | Phone number |
|-----------------|--|
| Australia | 61-2-9756-2359 |
| England | 44-1628-478011 |
| France | 33 1-48 25 35 95 |
| Germany | 49-89-140-9331 |
| Taiwan | 886-2-719-6075 |
| Thailand | 662-531-8111 |
| USA | Disc: 405-936-1600; Tape: 405-936-1630 |

FAX services

SeaFAX®

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

| Location | Phone number |
|-----------------|--|
| Australia | 61-2-9756-5170 |
| England | 44-1628-894084 |
| USA | Disc: 405-936-1620; Tape: 405-936-1640 |

Seagate technical support FAX

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

| Location | Phone number |
|-----------------|---------------------|
| Australia | 61-2-9725-4052 |
| England | 44-1628-890660 |
| France | 33 1-46 04 42 50 |
| Germany | 49-89-1430-5100 |

| Location | Phone number |
|-----------|--|
| Hong Kong | 852-2368 7173 |
| Japan | 81-3-5462-2979 |
| Korea | 82-2-556-7294/4251 |
| Singapore | 65-488-7528 |
| Taiwan | 886-2-715-2923 |
| USA | Disc: 405-936-1685; Tape: 405-936-1683 |

Direct-support services

Seagate technical support

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

| Location | Phone number |
|-----------|---|
| Australia | 61-2-9725-3366 (9:00 A.M. to 5:00 P.M., M–F) |
| England | 44-1628-894083 (10:00 A.M. to 1:00 P.M., 2:00 P.M. to 5:00 P.M., M–F) |
| France | 33 1-41 86 10 86 (9:30 A.M. to 12:30 P.M., 2:00 P.M. to 5:00 P.M., M–F) |
| Germany | Disc: 49-89-140-9332; Tape: 49-89-140-9333 (9:30 A.M. to 12:30 P.M., 2:00 P.M. to 4:00 P.M., M–F) |
| Hong Kong | 852-2368 9918 |
| Korea | 82-2-556-8241 |
| Singapore | 65-488-7584 (9:00 A.M. to 12:00 P.M., 2:00 P.M. to 5:00 P.M., M–F) |
| Taiwan | 886-2-514-2237 |
| USA | Please dial 1-800-SEAGATE or 408-456-4496 for the specific product telephone number. (8:00 A.M. to 1:15 P.M., 2:30 P.M. to 7:00 P.M., Central time, M–F) |

SeaTDD™ 405-936-1687

Using a telecommunications device for the deaf (TDD), you can send questions or comments 24 hours daily and exchange messages with a technical support specialist between 8:00 A.M. to 1:15 P.M. and 2:30 P.M. to 7:00 P.M. (Central time) Monday through Friday.

Customer service centers

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

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

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