Seagate

Cheetah X15 Disc Drive:

ST318451LW/LC

ST39251LC

Product Manual, Volume 1

Manual abstract:

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... Product Manual, Volume 1 ..
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Schweiss/G. Velaski L. Newman/J. Nowitzke L. Newman/B. Hohn Sheets Affected 1/1, v thru viii, 1 thru 80, and back cover front cover, 9, 13, 15, 17, 18, 40, 41, 45, 47, 49, 56, 57, 59, 60, 62-65, 67-69, 74, 76, and back cover. Page 9. Pages 3, 36, 51, and 52. Notice. Product Manual 83329484 is Volume 1 of a two volume document with the SCSI Interface information in the Volume 2 SCSI Interface Product Manual, part number 75789509.

If you need the SCSI Interface information, order the Volume 2 Interface Manual, part 75789509. number Cheetah X15 Product Manual, Rev. E v Contents 1.0 2.0 Scope . . . . . .
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0 Scope This manual describes Seagate Technology® LLC, Cheetah X15TM disc drives. Cheetah X15 drives support the small computer system interface (SCSI) as described in the ANSI SCSI SPI-3 interface specifications to the extent described in this manual. The SCSI Interface Product Manual (part number 75789509) describes general SCSI interface characteristics of this and other families of Seagate drives. From this point on in this product manual the reference to Cheetah X15 models is referred to as "the drive" unless references to individual models are necessary. Figure 1.
Cheetah X15 family drive (ST318451LW shown) 2 Cheetah X15 Product Manual, Rev. E Cheetah X15 Product Manual, Rev. E 3 2.0 Applicable standards and reference documentation The drive has been developed as a system peripheral to the highest standards of design and construction. The drive depends upon its host equipment to provide adequate power and environment in order to achieve optimum performance and compliance with applicable industry and governmental regulations. Special attention must be given in the areas of safety, power distribution, shielding, audible noise control, and temperature regulation. In particular, the drive must be securely mounted in order to guarantee the specified performance characteristics. Mounting by bottom holes must meet the requirements of Section 8.4. 2.

1 Standards The Cheetah X15 family complies with Seagate standards as noted in the appropriate sections of this Manual and the Seagate SCSI Interface Product Manual, part number 75789509 (Vol. 2). The Cheetah X15 disc drive is a UL recognized component per UL1950, CSA certified to CSA C22.2 No. 95095, and VDE certified to VDE 0805 and EN60950. 2.1.1 Electromagnetic compatibility The drive, as delivered, is designed for system integration and installation into a suitable enclosure prior to use. As such the drive is supplied as a subassembly and is not subject to Subpart B of Part 15 of the FCC Rules and Regulations nor the Radio Interference Regulations of the Canadian Department of Communications. The design characteristics of the drive serve to minimize radiation when installed in an enclosure that provides reasonable shielding.
As such, the drive is capable of meeting the Class B limits of the FCC Rules and Regulations of the Canadian Department of Communications when properly packaged. However, it is the user's responsibility to assure that the drive meets the appropriate EMI requirements in their system. Shielded I/O cables may be required if the enclosure does not provide adequate shielding. If the I/O cables are external to the enclosure, shielded cables should be used, with the shields grounded to the enclosure and to the host controller. 2.
1.2 Electromagnetic susceptibility As a component assembly, the drive is not required to meet any susceptibility performance requirements. It is the responsibility of those integrating the drive within their systems to perform those tests required and design their system to ensure that equipment operating in the same system as the drive or external to the system does not adversely affect the performance of the drive. See Section 5.1.
1 and Table 3, 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: · · · · · · · Typical current use microprocessor 3.5-inch floppy disc drive Keyboard Monitor/display Printer External modem Mouse Although the test system with this Seagate model complies to the directives/standard(s), we cannot guarantee that all systems will comply. The computer manufacturer or system integrator shall confirm EMC compliance and provide CE Marking and C-Tick Marking for their product. Electromagnetic compliance for the European Union If this model has the CE Marking it complies with the European Union requirements of the Electromagnetic Compatibility Directive 89/336/EEC of 03 May 1989 as amended by Directive 92/31/EEC of 28 April 1992 and Directive 93/68/EEC of 22 July 1993. 4 Australian C-Tick Cheetah X15 Product Manual, Rev.

E 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 Seagate P/N 83329485 Seagate P/N 75789512 Seagate P/N 75789509 Cheetah X15 Installation Guide Safety and Regulatory Agency Specifications SCSI Interface Product Manual Applicable

ANSI small computer system interface (SCSI) document numbers: T10/1143D T10/1236D T10/996D T10/1157D T10/1302D SFF-8046 Package Test Specification Package Test Specification Specification, Acoustic Test Requirements, and Procedures Enhanced SCSI Parallel Interface (EPI) Primary Commands-2 (SPC-2) SCSI Block Commands (SBC) SCSI Architectural Model-2 (SAM-2) SPI-3 (SCSI Parallel Interface version 3) Specification for 80-pin connector Seagate P/N 30190-001 (under 100 lb.

) Seagate P/N 30191-001 (over 100 lb.) Seagate P/N 30553-001 In case of conflict between this document and any referenced document, this document takes precedence. Cheetah X15 Product Manual, Rev. E 5 3.0 General description Cheetah X15 drives combine giant magnetoresistive (GMR) heads, partial response/maximum likelihood (PRML) read channel electronics, embedded servo technology, and a wide Ultra160 SCSI interface to provide high performance, high capacity data storage for a variety of systems including engineering workstations, network servers, mainframes, and supercomputers. Ultra160 SCSI uses negotiated transfer rates. These transfer rates will occur only if your host adapter supports these data transfer rates and is compatible with the required hardware requirements of the I/O circuit type.

This drive also operates at SCSI-1 and SCSI-2 data transfer rates for backward compatibility with non-Ultra/Ultra2/ Ultra160 SCSI host adapters. Table 1 lists the features that differentiate the Cheetah X15 models. Table 1: Drive model number vs. differentiating features Number of active heads Model number Cache [2] (kbytes) I/O circuit type [1] Number of I/O connector pins Number of I/O data bus bits ST318451LW ST318451LC ST39251LC [1] [2] 10 10 4,096 4,096 Single-ended (SE) and low voltage differential (LVD) Single-ended (SE) and low voltage differential (LVD) 68 80 16 16 See Section 9.6 for details and definitions.

See Section 4.5 for cache details. The drive records and recovers data on approximately 2.5-inch (65 mm) non-removeable discs. The drive supports the Small Computer System Interface (SCSI) as described in the ANSI SCSI interface specifications to the extent described in this manual (volume 1), which defines the product performance characteristics of the Cheetah X15 family of drives, and the SCSI Interface Product Manual (volume 2), part number 75789509, which describes the general interface characteristics of this and other families of Seagate SCSI drives.

The drive's interface supports multiple initiators, disconnect/reconnect, self-configuring host software, and automatic features that relieve the host from the necessity of knowing the physical characteristics of the targets (logical block addressing is used). The head and disc assembly (HDA) is sealed at the factory. Air circulates within the HDA through a nonreplaceable filter to maintain a contamination-free HDA environment. Refer to Figure 2 for an exploded view of the drive. This exploded view is for information only--never disassemble the HDA and do not attempt to service items in the sealed enclosure (heads, media, actuator, etc.) as this requires special facilities. The drive contains no replaceable parts. Opening the HDA voids your warranty. Cheetah X15 drives use a dedicated landing zone at the innermost radius of the media to eliminate the possibility of destroying or degrading data by landing in the data zone. The drive automatically goes to the landing zone when power is removed.

An automatic shipping lock prevents potential damage to the heads and discs that results from movement during shipping and handling. The shipping lock automatically disengages when power is applied to the drive and the head load process begins. Cheetah X15 drives decode track 0 location data from the servo data embedded on each surface to eliminate mechanical transducer adjustments and related reliability concerns. A high-performance actuator assembly with a low-inertia, balanced, patented, straight-arm design provides excellent performance with minimal power dissipation. 6 Cheetah X15 Product Manual, Rev. E Figure 2. Cheetah X15 family drive (exploded view) Cheetah X15 Product Manual, Rev. E 3.1 Standard features 7 The Cheetah X15 family has the following standard features: · Integrated Ultra160 SCSI controller Multimode SCSI drivers and receivers--single-ended (SE) and low voltage differential (LVD) 16 bit I/O data bus Asynchronous and synchronous data transfer protocol (supports Ultra160 transfer rate) Firmware downloadable via SCSI interface Selectable even byte sector sizes from 512 to 2,064 bytes/sector Programmable sector reallocation scheme Flawed sector reallocation at format time Programmable auto write and read reallocation Reallocation of defects on command (post format) ECC maximum burst correction length of 240 bits with a guaranteed burst correction length of 233 bits. Sealed head and disc assembly No preventative maintenance or adjustment required Dedicated head landing zone Embedded servo design Self diagnostics performed when power is applied to the drive Zoned bit recording (ZBR) Vertical, horizontal, or top down mounting Dynamic spindle brake 4,096 kbytes data buffer Hot plug compatibility (Section 9.

6.4.2 lists proper host connector needed) for LC model drives Drive Self Test (DST) Supports SCSI bus fairness Media characteristics 3.2 The media used on the drive has an aluminum substrate coated with a thin film magnetic material, overcoated with a proprietary protective layer for improved durability and environmental protection. 3.

3 · · · · · · Performance Supports industry standard Ultra160 SCSI interface Programmable multi-segmentable cache buffer (see Section 4.5) 15k RPM spindle. Average latency = 2.0 ms Command queuing of up to 64 commands Background processing of queue Supports start and stop commands (spindle stops spinning) Reliability 3.4 · · · · · 1,200,000 hour MTBF LSI circuitry Balanced low mass rotary voice coil actuator Incorporates industry-standard Self-Monitoring, Analysis and Reporting Technology (S.

M.A.R.T.) 5-year warranty 8 3.5 Unformatted and formatted capacities Cheetah X15 Product Manual, Rev. E Formatted capacity depends on the number of spare reallocation sectors reserved and the number of bytes per sector. The following table shows the standard OEM model capacities: Formatted data block size 512 bytes/sector [1] Unformatted ST318451 ST39251 Notes. [1] 0222EE56h (18.35 GB) [2] 0111772Bh (9.

176 GB) [2] 23.86 GB 11.94 GB [2] 3.6 Sector size selectable at format time. Users having the necessary equipment may modify the data block size before issuing a format command and obtain different formatted capacities than those listed. See Mode Select Command and Format Command in the SCSI Interface Product Manual. User available capacity depends on spare reallocation scheme selected, the number of data tracks per sparing zone, and the number of alternate sectors (LBAs) per sparing zone. Programmable drive capacity Using the Mode Select command, the drive can change its capacity to something less than maximum. See the Mode Select Parameter List table in the SCSI Interface Product Manual.

Refer to the Parameter list block descriptor number of blocks field.
A value of zero in the number of blocks field indicates that the drive shall not change the capacity it is currently formatted to have. A number in the number of blocks field that is less than the maximum number of LBAs changes the total drive capacity to the value in the block descriptor number of blocks field. A value greater than the maximum number of LBAs is rounded down to the maximum capacity. 3.7 Factory installed accessories OEM Standard drives are shipped with the Cheetah X15 Installation Guide, part number 83329485, and the Safety and Regulatory Agency Specifications, part number 75789512 (unless otherwise specified).
The factory also ships with the drive a small bag of jumper plugs used for the J2, J5, and J6 option select jumper headers. 3.8 Options (factory installed) All customer requested options are incorporated during production or packaged at the manufacturing facility before shipping. Some of the options available are (not an exhaustive list of possible options): · Other capacities can be ordered depending on sparing scheme and sector size requested. · 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. · The Cheetah X15 Installation Guide, part number 83329485, is usually included with each standard OEM drive shipped, but extra copies may be ordered. · The Safety and Regulatory Agency Specifications, part number 75789512, is usually included with each standard OEM drive shipped, but extra copies may be ordered. 3.9 Accessories (user installed) The following accessories are available. All accessories may be installed in the field. · Single unit shipping pack. Cheetah X15 Product Manual, Rev.

E 9 4.0 4.1 Performance characteristics Internal drive characteristics (transparent to user) ST318451 ST39251 Drive capacity Read/write heads Bytes/track Bytes/surface Tracks/surface (total) Tracks/inch Peak bits/inch Internal data rate Disc rotational speed Average rotational latency 4.2 18.35 10 176,843 1,835 10,377 21,400 343 385-508 15k 2.0 9.2 6 176,843 1,835 10,377 21,400 343 385-508 15k 2.0 GByte (formatted, rounded off values) Bytes (average, rounded off values) Mbytes (unformatted, rounded off values) Tracks (user accessible) TPI KBPI Mbits/sec (variable with zone) r/min msec SCSI performance characteristics (visible to user) The values given in Section 4.2.1 apply to all models of the Cheetah X15 family unless otherwise specified.
Refer to Section 9.10 and to the SCSI Interface Product Manual for additional timing details. 4.2.1 Access time [5] Including controller overhead [1] [3] Drive level Not including controller overhead [1] [3] Drive level Read msec Average Typical [2] 4.
1 Single Track Typical [2] 0.8 Full Stroke Typical [2] 7.7 4.2.2 Write 4.
7 1.0 8.2 Read msec 3.9 0.5 7.5 Write 4.5 0.7 8.0 Format command execution time (minutes) [1] ST318451 ST39251 Maximum (with verify) Maximum (no verify) 4.2.

3 60 30 30 15 Generalized performance characteristics 1 to 1 Minimum sector interleave Data buffer transfer rate to/from disc media (one 512-byte sector): Min. Max. [3] [3] 37.4 48.9 MBytes/sec MBytes/sec SCSI interface data transfer rate (asynchronous): Maximum instantaneous one byte wide Maximum instantaneous two bytes wide Synchronous formatted transfer rate In low voltage differential (LVD) interface mode 5.0 Mbytes/sec [4] 10.0 Mbytes/sec [4] Ultra2 SCSI 5.0 to 80 Mbytes/sec Ultra160 SCSI 5.0 to 160 Mbytes/sec 10 Sector Sizes: Default Variable 512 byte user data blocks Cheetah X15 Product Manual, Rev. E 512 to 2,064 bytes per sector in even number of bytes per sector.*
If n (number of bytes per sector) is odd, then n-1 will be used. Yes Negligible 2.00 msec Read/write consecutive sectors on a track Flaw reallocation performance impact (for flaws reallocated at format time using the spare sectors per sparing zone reallocation scheme.) Average rotational latency Notes for Section 4.2.
[1] [2] [3] [4] [5] 4.3 Execution time measured from receipt of the last byte of the Command Descriptor Block (CDB) to the request for a Status Byte Transfer to the Initiator (excluding connect/disconnect). Typical access times are measured under nominal conditions of temperature, voltage, and horizontal orientation as measured on a representative sample of drives. Assumes no errors and no sector has been relocated. Assumes system ability to support the rates listed and no cable loss.
Access time = controller overhead + average seek time. Access to data = controller overhead + average seek time + latency time. Start/stop time After DC power at nominal voltage has been applied, the drive becomes ready within 20 seconds if the Motor Start Option is disabled (i.e. the motor starts as soon as the power has been applied). If a recoverable error condition is detected during the start sequence, the drive executes a recovery procedure which may cause the time to become ready to exceed 20 seconds. During spin up to ready time the drive responds to some commands over the SCSI interface in less than 3 seconds after application of power. Stop time is 30 seconds from removal of DC power. If the Motor Start Option is enabled, the internal controller accepts the commands listed in the SCSI Interface Product Manual less than 3 seconds after DC power has been applied. After the Motor Start Command has been received the drive becomes ready for normal operations within 20 seconds typically (excluding an error recovery procedure).

The Motor Start Command can also be used to command the drive to stop the spindle (see the SCSI Interface Product Manual). There is no power control switch on the drive. 4.4 Prefetch/multi-segmented cache control The drive provides prefetch (read look-ahead) and multi-segmented cache control algorithms that in many cases can enhance system performance. "Cache" as used herein refers to the drive buffer storage space when it is used in cache operations. To select prefetch and cache features the host sends the Mode Select command with the proper values in the applicable bytes in Mode Page 08h (see the SCSI Interface Product Manual). Prefetch and cache operation are independent features from the standpoint that each is enabled and disabled independently via the Mode Select command. However, in actual operation the prefetch feature overlaps cache operation somewhat as is noted in Section 4.5.1 and 4.
5.2. All default cache and prefetch Mode parameter values (Mode Page 08h) for standard OEM versions of this drive family are given in Tables 9. 4.5 Cache operation In general, 3,600 kbytes of the physical buffer space in the drive can be used as storage space for cache operations.
The buffer can be divided into logical segments (Mode Select Page 08h, byte 13) from which data is read and to which data is written.

The drive supports a maximum of 64 cache segments. The drive maintains a table of logical block disk medium addresses of the data stored in each segment of the buffer. If cache operation is enabled (RCD bit = 0 in Mode Page 08h, byte 2, bit 0. See SCSI Interface Product Manual), data Cheetah X15 Product Manual, Rev.

E 11 requested by the host with a Read command is retrieved from the buffer (if it is there), before any disc access is initiated. If cache operation is not enabled, the buffer (still segmented with required number of segments) is still used, but only as circular buffer segments during disc medium read operations (disregarding Prefetch operation for the moment). That is, the drive does not check in the buffer segments for the requested read data, but goes directly to the medium to retrieve it. The retrieved data merely passes through some buffer segment on the way to the host. On a cache miss, all data transfers to the host are in accordance with buffer-full ratio rules. On a cache hit the drive ignores the buffer-full ratio rules. See explanations associated with Mode page 02h (disconnect/reconnect control) in the SCSI Interface Product Manual. The following is a simplified description of a read operation with cache operation enabled: Case A - A Read command is received and the first logical block (LB) is already in cache: 1. Drive transfers to the initiator the first LB requested plus all subsequent contiguous LBs that are already in the cache. This data may be in multiple segments.

2. When the requested LB is reached that is not in any cache segment, the drive fetches it and any remaining requested LBs from the disc and puts them in a segment of the cache. The drive transfers the remaining requested LBs from the cache to the host in accordance with the disconnect/reconnect specification mentioned above. 3. If the prefetch feature is enabled, refer to Section 4.5.2 for operation from this point. Case B - A Read command requests data, the first LB of which is not in any segment of the cache: 1. The drive fetches the requested LBs from the disc and transfers them into a segment, and from there to the host in accordance with the disconnect/reconnect specification referred to in case A. 2.

If the prefetch feature is enabled, refer to Section 4.5.2 for operation from this point. Each buffer segment is actually a self-contained circular storage (wrap-around occurs), the length of which is an integer number of disc medium sectors. The wrap-around capability of the individual segments greatly enhances the buffer's overall performance as a cache storage, allowing a wide range of user selectable configurations, which includes their use in the prefetch operation (if enabled), even when cache operation is disabled (see Section 4.

5.2). The number of segments is set dynamically by the drive and cannot be set by the host. The size in Kbytes of each segment is not reported by the Mode Sense command page 08h, bytes 14 and 15. The value 0XFFFF is always reported.

If a size specification is sent by the host in a Mode Select command (bytes 14 and 15) no new segment size is set up by the drive, and if the STRICT bit in Mode page 00h (byte 2, bit 1) is set to one, the drive responds as it does for any attempt to change unchangeable parameters (see SCSI Interface Product Manual). 4.5.1 Caching write data Write caching is a write operation by the drive that makes use of a drive buffer storage area where the data to be written to the medium is stored in one or more segments while the drive performs the write command. If read caching is enabled (RCD=0), then data written to the medium is retained in the cache to be made available for future read cache hits. The same buffer space and segmentation is used as set up for read functions. The buffer segmentation scheme is set up or changed independently, having nothing to do with the state of RCD. When a write command is issued, if RCD=0, the cache is first checked to see if any logical blocks that are to be written are already stored in the cache from a previous read or write command. If there are, the respective cache segments are cleared. The new data is cached for subsequent Read commands.

If the number of write data logical blocks exceeds the size of the segment being written into, when the end of the segment is reached, the data is written into the beginning of the same cache segment, overwriting the data that was written there at the beginning of the operation. However, the drive does not overwrite data that has not yet been written to the medium. If write caching is enabled (WCE=1), then the drive may return GOOD status on a write command after the data has been transferred into the cache, but before the data has been written to the medium. If an error occurs while writing the data to the medium, and GOOD status has already been returned, a deferred error will be generated. 12 Cheetah X15 Product Manual, Rev. E The Synchronize Cache command may be used to force the drive to write all cached write data to the medium. Upon completion of a Synchronize Cache command, all data received from previous write commands will have been written to the medium. Tables 9 show Mode default settings for the drives. 4.5.

2 Prefetch operation If the Prefetch feature is enabled, data in contiguous logical blocks on the disc immediately beyond that which was requested by a Read command can be retrieved and stored in the buffer for immediate transfer from the buffer to the host on subsequent Read commands that request those logical blocks (this is true even if cache operation is disabled). Though the prefetch operation uses the buffer as a cache, finding the requested data in the buffer is a prefetch hit, not a cache operation hit. Prefetch is enabled using Mode Select page 08h, byte 12, bit 5 (Disable Read Ahead - DRA bit). DRA bit = 0 enables prefetch. Since data that is prefetched replaces data already in some buffer segment(s), the host can limit the amount of prefetch data to optimize system performance.

The max prefetch field (bytes 8 and 9) limits the amount of prefetch. The drive does not use the Prefetch Ceiling field (bytes 10 and 11). During a prefetch operation, the drive crosses a cylinder boundary to fetch more data only if the Discontinuity (DISC) bit is set to one in bit 4 of byte 2 of Mode parameters page 08h. Whenever prefetch (read look-ahead) is enabled (enabled by DRA = 0), it operates under the control of ARLA (Adaptive Read Look-Ahead). If the host uses software interleave, ARLA enables prefetch of contiguous blocks from the disc when it senses that a prefetch hit will likely occur, even if two consecutive read operations were not for physically contiguous blocks of data (e.

g., "software interleave"). ARLA disables prefetch when it decides that a prefetch hit will not likely occur. If the host is not using software interleave, and if two sequential read operations are not for contiguous blocks of data, ARLA disables prefetch, but as long as sequential read operations request contiguous blocks of data, ARLA keeps prefetch enabled.

Cheetah X15 Product Manual, Rev. E 13 5.0 Reliability specifications The following reliability specifications assume correct host/drive operational interface, including all interface timings, power supply voltages, environmental requirements and drive mounting constraints (see Section 8.4). Seek Errors Read Error Rates [1] Recovered Data Unrecovered Data Miscorrected Data MTBF Service Life Preventive Maintenance Note. [1] 5.

1 Error rate specified with automatic retries and data correction with ECC enabled and all flaws reallocated. Error rates Less than 10 in 108 seeks Less than 10 errors in 1012 bits transferred (OEM default settings) Less than 1 sector in 1015 bits transferred (OEM default settings) Less than 1 sector in 1021 bits transferred 1,200,000 hours 5 years None required The error rates stated in this specification assume the following: · The drive is operated per this specification using DC power as defined in this manual (see Section 6.2). · The drive has been formatted with the SCSI FORMAT command. · Errors caused by media defects or host system failures are excluded from error rate computations. Refer to Section 3.2, "Media Characteristics." · Assume random data. 5.1. 1 Environmental interference When evaluating systems operation under conditions of Electromagnetic Interference (EMI), the performance of the drive within the system shall be considered acceptable if the drive does not generate an unrecoverable condition. An unrecoverable error, or unrecoverable condition, is defined as one that: · Is not detected and corrected by the drive itself; · Is not capable of being detected from the error or fault status provided through the drive or SCSI interface; or · Is not capable of being recovered by normal drive or system recovery procedures without operator intervention. 5.1.2 Read errors Before determination or measurement of read error rates: · The data that is to be used for measurement of read error rates must be verified as being written correctly on the media.

· All media defect induced errors must be excluded from error rate calculations. 5.1.3 Write errors Write errors can occur as a result of media defects, environmental interference, or equipment malfunction. Therefore, write errors are not predictable as a function of the number of bits passed.

If 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 which cannot be corrected within two attempts at writing the record with a read verify after each attempt (excluding media defects). 5.1.4 Seek errors A seek error is defined as a failure of the drive to position the heads to the addressed track. There shall be no more than ten recoverable seek errors in 108 physical seek operations. After detecting an initial seek error, the drive automatically performs an error recovery process. If the error recovery process fails, a seek positioning 14 Cheetah X15 Product Manual, Rev. E error (15h) is reported with a Medium error (3h) or Hardware error (4h) reported in the Sense Key. This is an unrecoverable seek error.

Unrecoverable seek errors are classified as failures for MTBF calculations. Refer to the SCSI Interface Product Manual, part number 75789509, for Request Sense information. 5.2 Reliability and service You can enhance the reliability of Cheetah X15 disc drives by ensuring that the drive receives adequate cooling. Section 6.0 provides temperature measurements and other information that may be used to enhance the service life of the drive. Section 8.3.1 provides recommended air-flow information. 5.

2.1 Mean time between failure The production disc drive shall achieve an MTBF of 1,200,000 hours when operated in an environment that ensures the case temperatures specified in Section 6.4.1, Table 4 are not exceeded. Short-term excursions up to the specification limits of the operating environment will not affect MTBF performance.

Continual or sustained operation at case temperatures above the values shown in Table 4 may degrade product reliability. The MTBF target is specified as device power-on hours (POH) for all drives in service per failure. Estimated power-on operating hours in the period = MTBF per measurement period Number of drive failures in the period Estimated power-on operation hours means power-up hours per disc drive times the total number of disc drives in service. Each disc drive shall have accumulated at least nine months of operation. Data shall be calculated on a rolling average base for a minimum period of six months.

MTBF is based on the following assumptions: · · · · 8,760 power-on hours per year. 250 average on/off cycles per year. Operations at nominal voltages. Systems will provide adequate cooling to ensure the case temperatures specified in Section 6.4.1 are not exceeded. Drive failure means any stoppage or substandard performance caused by drive malfunction. A S.M.A.

R.T. predictive failure indicates that the drive is deteriorating to an imminent failure and is considered an MTBF hit. 5.2.2 Field failure rate vs time The expected field failure rate is listed below. Drive utilization will vary. An estimated range of utilization is: · · · · 720 power-on hours (POH) per month. 250 on/off cycles per year. Read/seek/write operation 20% of power-on hours.

Systems will provide adequate cooling to ensure the case temperatures specified in Section 6.4.1 are not exceeded. Month 1 Month 2 Month 3 Month 4 Month 5 Month 6 Month 7 2,364 PPM 1,422 PPM 1,403 PPM 1,391 PPM 1,317 PPM 1,255 PPM 1,162 PPM Failure rate is calculated as follows: · No system-induced failures are counted · Based on 1,200,000 MTBF and 720 power-on hours per month · Month 1's rate includes a 300 PPM installation failure Cheetah X15 Product Manual, Rev. E 5.

2.3 Preventive maintenance 15 No routine scheduled preventive maintenance shall be required. 5.2.4 Service life The drive shall have a useful service life of five years.

Depot repair or replacement of major parts is permitted during the lifetime (see Section 5.2.5). 5.2.5 Service philosophy Special equipment is required to repair the drive HDA. In order to achieve the above service life, repairs must be performed only at a properly equipped and staffed service and repair facility. Troubleshooting and repair of PCBs in the field is not recommended, because of the extensive diagnostic equipment required for effective servicing. Also, there are no spare parts available for this drive. Drive warranty is voided if the HDA is opened.

5.2.6 Service tools No special tools are required for site installation or recommended for site maintenance. Refer to Section 5.2.5. The depot repair philosophy of the drive precludes the necessity for special tools. Field repair of the drive is not practical since there are no user purchasable parts in the drive.

5.2.

7 Hot plugging Cheetah X15 disc drives The ANSI SPI-3 (T10/1302D) document defines the physical requirements for removal and insertion of SCSI devices on the SCSI bus. Four cases are addressed. The cases are differentiated by the state of the SCSI bus when the removal or insertion occurs. Case 1 - All bus devices powered off during removal or insertion Case 2 - RST signal asserted continuously during removal or insertion Case 3 - Current I/O processes not allowed during insertion or removal Case 4 - Current I/O process allowed during insertion or removal, except on the device being changed Seagate Cheetah X15 disc drives support all four hot plugging cases. Provision shall be made by the system such that a device being inserted makes power and ground connections prior to the connection of any device signal contact to the bus.

A device being removed shall maintain power and ground connections after the disconnection of any device signal contact from the bus (see SFF-8046, SCA-2 specification). It is the responsibility of the systems integrator to assure that no hazards from temperature, energy, voltage, or ESD potential are presented during the hot connect/disconnect operation. All I/O processes for the SCSI device being inserted or removed shall be quiescent. All SCSI devices on the bus shall have receivers that conform to the SPI-3 standard. If the device being hot plugged uses single-ended (SE) drivers and the bus is currently operating in low voltage differential (LVD) mode, then all I/O processes for all devices on the bus must be completed, and the bus quiesced, before attempting to hot plug. Following the insertion of the newly installed device, the SCSI host adapter must issue a Bus Reset, followed by a synchronous transfer negotiation. Failure to perform the SCSI Bus Reset could result in erroneous bus operations. The SCSI bus termination and termination power source shall be external to the device being inserted or removed. End users should not mix devices with high voltage differential (HVD) drivers and receivers and devices with SE, LVD, or multimode drivers and receivers on the same SCSI bus since the common mode voltages in the HVD environment may not be controlled to safe levels for SE and LVD devices (see ANSI SPI-3). The disc drive spindle must come to a complete stop prior to completely removing the drive from the cabinet chassis. Use of the Stop Spindle command or partial withdrawal of the drive, enough to be disconnected from the power source, prior to removal are methods for insuring that this requirement is met. During drive insertion, care should be taken to avoid exceeding the limits stated in Section 6.4.4, "Shock and vibration" in this manual. 16 5.

2.8 S.M.A.R.T. Cheetah X15 Product Manual, Rev. E S.M.A.

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

The firmware will monitor specific attributes for degradation over time but cannot predict instantaneous drive failures. Each attribute has been selected to monitor a specific set of failure conditions in the operating performance of the drive, and the thresholds are optimized to minimize "false" and "failed" predictions. Controlling S.M.A.

R.T. The operating mode of S.M.A.R.T. is controlled by the DEXCPT bit and the PERF bit of the "Informational Exceptions Control Mode Page" (1Ch). The DEXCPT bit is used to enable or disable the S.M.

A.R.T. process. Setting the DEXCPT bit will disable all S.M.A.R.T. functions.

When enabled, S.M.A.R.T.

will collect on-line data as the drive performs normal read/write operations. When the PERF bit is set, the drive is considered to be in "On-line Mode Only" and will not perform off-line functions. The process of measuring off-line attributes and saving data can be forced by the Rezero Unit command. Forcing S.M.A.R.T. will reset the timer so that the next scheduled interrupt will be two hours. The drive can be interrogated by the host to determine the time remaining before the next scheduled measurement and data logging process will occur. This is accomplished by a log sense command to log page 0x3E. The purpose is to allow the customer to control when S.M.A.R.

T. interruptions occur. As described above, forcing S.M.A.R.T by the Rezero Unit command will reset the timer. Performance impact S.M.A.

R.T. attribute data will be saved to the disc for the purpose of recreating the events that caused a predictive failure. The drive will measure and save parameters once every two hours subject to an idle period on the SCSI bus. The process of measuring off-line attribute data and saving data to the disc is uninterruptable and the maximum delay is summarized below: Maximum processing delay On-line only delay DEXCPT = 0, PERF = 1 50 milliseconds Fully enabled delay DEXCPT = 0, PERF = 0 300 milliseconds S.

M.A.R.T. delay times Reporting control Reporting is controlled in the Informational Exceptions Control Page (1Ch).

Subject to the reporting method, the firmware will issue a 01-5D00 sense code to the host. The error code is preserved through bus resets and power cycles. Determining rate S.M.A.R.T. monitors the rate at which errors occur and signals a predictive failure if the rate of degraded error rate 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 rate, hence for each attribute the occurrence of an error is 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 simply 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 the interval. If the number of errors exceeds the threshold before the interval expires, then the error rate is considered to be unacceptable. If the number of errors does not exceed the threshold before the interval expires, then the error rate is considered to be acceptable. In either case, the interval and failure counters are reset and the process starts over. Cheetah X15 Product Manual, Rev. E Predictive failures 17 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 whenever the error rate is unacceptable and decremented (not to exceed zero) whenever the error rate is acceptable. Should the counter continually be incremented 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. 5.2.9 Thermal Monitor Cheetah X15 drives implement a temperature warning system which: 1. Signals the host if the temperature exceeds a value which would threaten the drive. 2. Signals the host if the temperature exceeds a user-specified value. 3. Saves a S.M.
A.R.T. data frame on the drive which exceed the threatening temperature value. A temperature sensor monitors the drive temperature and issues a warning over the interface when the temperature exceeds a set threshold.
The temperature is measured at power-up and then at ten-minute intervals after power-up. The thermal monitor system generates a warning code of 01-0B01 when the temperature exceeds the specified limit in compliance with the SCSI standard. The drive temperature is reported in the FRU code field of mode sense data. You can use this information to determine if the warning is due to the temperature exceeding the drive threatening temperature or the user-specified temperature. This feature is controlled by the Enable Warning (EWasc) bit, and the reporting mechanism is controlled by the Method of Reporting Informational Exceptions field (MRIE) on the Informational Exceptions Control (IEC) mode page (1Ch).
The current algorithm implements two temperature trip points. The first trip point is set at 65°C which is the maximum temperature limit according to the drive specification. The second trip point is user-selectable using the Log Select command. The reference temperature parameter in the temperature log page (see Table 2) can be used to set this trip point. The default value for this drive is 65°C, however, you can set it to any value in the range of 0 to 65°C. If you specify a temperature greater than 65°C in this field, the temperature is rounded down to 65°C. A sense code is sent to the host to indicate the rounding of the parameter field. Table 2: Temperature Log page (0Dh) Parameter Code 0000h 0001h Description Primary Temperature Reference Temperature When the first temperature trip point is exceeded, S.M.A.

R.T. data is collected and a frame is saved to the disc. 5.2.10 Drive Self Test (DST) Drive Self Test (DST) is a technology designed to recognize drive fault conditions that qualify the drive as a failed unit. DST validates the functionality of the drive at a system level. There are two test coverage options implemented in DST: 1. Extended test 2. Short text The most thorough option is the extended test that performs various tests on the drive and scans every logical block address (LBA) of the drive.
The short test is time-restricted and limited in length--it does not scan the entire media surface, but does some fundamental tests and scans portions of the media. If DST encounters an error during either of these tests, it reports a fault condition. If the drive fails the test, remove it from service and return it to Seagate for service. 18 5.2.
10.1 DST Failure Definition Cheetah X15 Product Manual, Rev. E The drive will present a "diagnostic failed" condition through the self-tests results value of the diagnostic log page if a functional failure is encountered during DST. The channel and servo parameters are not modified to test the drive more stringently, and the number of retries are not reduced. All retries and recovery processes are enabled during the test.
If data is recoverable, no failure condition will be reported regardless of the number of retries required to recover the data. The following conditions are considered DST failure conditions: · · · · Seek error after retries are exhausted Track-follow error after retries are exhausted Read error after retries are exhausted Write error after retries are exhausted. Recovered errors will not be reported as diagnostic failures. 5.2.10.2 Implementation This section provides all of the information necessary to implement the DST function on this drive. 5.2.10.

2.1 State of the drive prior to testing The drive must be in a ready state before issuing the Send Diagnostic command. There are multiple reasons why a drive may not be ready, some of which are valid conditions, and not errors. For example, a drive may be in process of doing a format, or another DST. It is the responsibility of the host application to determine the "not ready" cause. While not technically part of DST, a Not Ready condition also qualifies the drive to be returned to Seagate as a failed drive. A Drive Not Ready condition is reported by the drive under the following conditions: · · · · Motor will not spin Motor will not lock to speed Servo will not lock on track Drive cannot read configuration tables from the disc In these conditions, the drive responds to a Test Unit Ready command with an 02/04/00 or 02/04/03 code. 5.2.10.
2.2 Invoking DST To invoke DST, submit the Send Diagnostic command with the appropriate Function Code (001b for the short test or 010b for the extended test) in bytes 1, bits 5, 6, and 7. Refer to the Seagate SCSI Interface Manual, Volume 3, part number 75789509 for additional information about invoking DST. 5.2.
10.2.3 Short and extended tests DST has two testing options: 1. short 2. extended These testing options are described in the following two subsections. Each test consists of three segments: an electrical test segment, a servo test segment, and a read/verify scan segment. Short test (Function Code: 001b) The purpose of the short test is to provide a time-limited test that tests as much of the drive as possible within 120 seconds. The short test does not scan the entire media surface, but does some fundamental tests and scans portions of the media. A complete read/verify scan is not performed and only factual failures will report a fault condition. This option provides a quick confidence test of the drive. Extended test (Function Code: 010b) The objective of the extended test option is to empirically test critical drive components. For example, the seek tests and on-track operations test the positioning mechanism. The read operation tests the read head element Cheetah X15 Product Manual, Rev. E 19 and the media surface. The write element is tested through read/write/read operations.

The integrity of the media is checked through a read/verify scan of the media. Motor functionality is tested by default as a part of these tests. The anticipated length of the Extended test is reported through the Control Mode page. 5.2.10.2.4 Log page entries When the drive begins DST, it creates a new entry in the Self-test Results Log page. The new entry is created by inserting a new self-test parameter block at the beginning of the self-test results log parameter section of the log page. Existing data will be moved to make room for the new parameter block.
The drive reports 20 parameter blocks in the log page. If there are more than 20 parameter blocks, the least recent parameter block will be deleted. The new parameter block will be initialized as follows: 1.

The Function Code field is set to the same value as sent in the DST command 2. The Self-Test Results Value field is set to Fh 3.
The drive will store the log page to non-volatile memory After a self-test is complete or has been aborted, the drive updates the Self-Test Results Value field in its SelfTest Results Log page in non-volatile memory. The host may use Log Sense to read the results from up to the last 20 self-tests performed by the drive. The self-test results value is a 4-bit field that reports the results of the test. If the field is zero, the drive passed with no errors detected by the DST. If the field is not zero, the test failed for the reason reported in the field.
The drive will report the failure condition and LBA (if applicable) in the Self-test Results Log parameter. The Sense key, ASC, ASCQ, and FRU are used to report the failure condition. 5.2.10.2.5 Abort There are several ways to abort a diagnostic. You can use a SCSI Bus Reset or a Bus Device Reset message to abort the diagnostic. You can abort a DST executing in background mode by using the abort code in the DST Function Code field. This will cause a 01 (self-test aborted by the application client) code to appear in the self-test results values log.

All other abort mechanisms will be reported as a 02 (self-test routine was interrupted by a reset condition). 5.2.11 Product warranty Beginning on the date of shipment to customer and continuing for a period of five years, Seagate warrants that each product (including components and subassemblies) or spare part that fails to function properly under normal use due to defect in materials on workmanship or due to nonconformance to the applicable specifications will be repaired or replaced, at Seagate's option and at no charge to customer, if returned by customer at customer's expense to Seagate's designated facility in accordance with Seagate's warranty procedure. Seagate will pay for transporting the repair or replacement item to customer. For more detailed warranty information refer to the Standard terms and conditions of Purchase for Seagate products. Shipping When transporting or shipping a drive, a Seagate approved container must be used. Keep your original box. They are easily identified by the Seagate-approved package label. Shipping a drive in a non-approved container voids the drive warranty.
Seagate repair centers may refuse receipt of components improperly packaged or obviously damaged in transit. Contact your Authorized Seagate Distributor to purchase additional boxes. Seagate recommends shipping by an air-ride carrier experienced in handling computer equipment. Product repair and return information Seagate customer service centers are the only facilities authorized to service Seagate drives. Seagate does not sanction any third-party repair facilities.
Any unauthorized repair or tampering with the factory-seal voids the warranty. 20 Cheetah X15 Product Manual, Rev. E Cheetah X15 Product Manual, Rev. E 21 6.0 Physical/electrical specifications This section provides information relating to the physical and electrical characteristics of the Cheetah X15 drive. 6.1 None. 6.2 DC power requirements AC power requirements The voltage and current requirements for a single drive are shown in the following table. Values indicated apply at the drive power connector. The table shows current values in Amperes. Table 3: DC power requirements ST318451 Notes SE mode LVD mode SE mode LVD mode ST39251 Voltage Regulation Average idle current DC Maximum starting current (peak DC) DC (peak AC) AC Delayed motor start (max) DC Peak operating current DC Maximum DC Maximum (peak) DC [1] [2] [5] +5 V ±5% X [1][7] 0.61 [3] [3] 0.67 0.94 +12 V 0.

61 1.42 3.26 0.03 1.05 1.15 2.29 +5 V 0.68 0.73 1.01 0.
57 0.8 0.81 1.41 +12 V 0.61 1.
42 3.26 0.03 1.05 1.15 2.
29 +5 V 0.61 0.67 0.94 0.53 0.66 0.70 1.08 +12 V 0.52 1.66 3.

35 0.03 0.92 1.07 2.29 +5 V 0.68 0.74 1.01 0.59 0.79 0.
83 1.41 +12 V ±5%[2] 0.52 1.66 3.35 0.
03 0.92 1.07 2.29 ±5%[2] ±5% ±5%[2] ±5% ±5%[2] ±5% [1][4] 0.51 X [1][6] 0.
67 [1] 0.70 1.08 [3] [4] [5] [6] Measured with average reading DC ammeter or equivalent sampling scope. Instantaneous current peaks will exceed these values. Power supply at nominal voltage. N = 6, 22 Degrees C ambient. For +12 V, a 10% tolerance is permissible during initial start of spindle, and must return to ±5% before 15,000 rpm is reached. The ±5% must be maintained after the drive signifies that its power-up sequence has been completed and that the drive is able to accept selection by the host initiator. See +12 V current profile in Figure 3. This condition occurs when the Motor Start Option is enabled and the drive has not yet received a Start Motor command.

See Section 6.2.1 "Conducted Noise Immunity." Specified voltage tolerance is inclusive of ripple, noise, and transient response. Operating condition is defined as random 8 block reads at 261 I/Os per second (277 I/Os per second for ST39251 models). Current and power specified at nominal voltages. Decreasing +5 volts by 5% increases 5 volt current by 3.2%. Decreasing +12 volt supply by 5% increases 12 volt current by 1.4% (2% for ST39251 models).
[7] During idle, the drive heads are relocated every 60 seconds to a random location within the band from three-quarters to maximum track. General Notes from Table 3: 1. Minimum current loading for each supply voltage is not less than 1.9% of the maximum operating current shown. 2.
The +5 and +12 volt supplies shall employ separate ground returns. 3. Where power is provided to multiple drives from a common supply, careful consideration for individual drive power requirements should be noted. Where multiple units are powered on simultaneously, the peak starting current must be available to each device. 4.
Parameters, other than spindle start, are measured after a 10-minute warm up. 5. No terminator power. 22 6.2.1 Conducted noise immunity Cheetah X15 Product Manual, Rev. E Noise is specified as a periodic and random distribution of frequencies covering a band from DC to 10 MHz. Maximum allowed noise values given below are peak to peak measurements and apply at the drive power connector. +5 V = +12 V = 6.2.

2 150 mV pp from 0 to 100 kHz and 100 mV pp from 100 kHz to 10 MHz. 150 mV pp from 0 to 100 kHz and 100 mV pp from 100 kHz to 10 MHz. Power sequencing The drive does not require power sequencing. The drive protects against inadvertent writing during power-up and down. Daisy-chain operation requires that power be maintained on the SCSI bus terminator to ensure proper termination of the peripheral I/O cables. To automatically delay motor start based on the target ID (SCSI ID) enable the Delay Motor Start option and disable the Enable Motor Start option on the J2 connector. See Section 8.1 for pin selection information. To delay the motor until the drive receives a Start Unit command, enable the Enable Remote Motor Start option on the J2 connector.