



**Zeus Serial ATA (SATA)
2.5-Inch Solid State Drive
Product Datasheet**



Export Administration Regulation

This document may contain technical data controlled by the U.S. Export Administration Regulations, and may be subject to the approval of the U.S. Department of Commerce prior to export. Any export, directly or indirectly, in contravention of the U.S. Export Administration Regulation is prohibited.

Trademark Information

The STEC name, logo and design are trademarks of STEC Inc. No right, license, or interest to such trademarks is granted hereunder, and you agree that no such right, license, or interest shall be asserted by you with respect to such trademark. Other product and corporate names mentioned in this document are used for identification purposes only and may be trademarks or registered trademarks of their respective companies.

Disclaimer of Liability

The performance information and specifications furnished in this document reflect the engineering development objectives of STEC Inc. and should be used for comparative analysis and reference purposes. The content of this document is accurate as of the date of this publication; however, the information contained herein, including but not limited to any instructions, descriptions and product specifications, is subject to change without prior notice.

STEC INC. (STEC) PROVIDES NO WARRANTY WITH REGARD TO THIS DOCUMENT OR ANY OTHER INFORMATION CONTAINED HEREIN AND HEREBY EXPRESSLY DISCLAIMS ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE WITH REGARD TO ANY OF THE FOREGOING. STEC ASSUMES NO LIABILITY FOR ANY DAMAGES INCURRED DIRECTLY OR INDIRECTLY FROM ANY TECHNICAL OR TYPOGRAPHICAL ERRORS OR OMISSIONS CONTAINED HEREIN. IN NO EVENT SHALL STEC BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL, SPECIAL, OR EXEMPLARY DAMAGES, WHETHER BASED ON TORT, CONTRACT OR OTHERWISE, ARISING OUT OF OR IN CONNECTION WITH THIS DOCUMENT OR ANY OTHER INFORMATION CONTAINED HEREIN OR THE USE THEREOF.

Copyright Notice

Copyright ©2007 by STEC Inc. All rights reserved. This guide is copyrighted by STEC Inc., with all rights reserved. Information contained in this document, including but not limited to any instructions, descriptions and product specifications, is company private to STEC and shall not be modified, used, copied, reproduced or disclosed in whole or in part, in any form or by any means, electronic or mechanical, for any purpose, without the written consent of STEC.

CONVENTIONS

The following icons are used throughout this document to identify additional information of which the reader should be aware.

	SHOCK HAZARD: This icon indicates the danger of an electrical shock that may harm or otherwise prove fatal to the user.
	CAUTION: This icon indicates the existence of a hazard that could result in equipment or property damage or equipment failure if the safety instruction is not observed.
	ELECTROSTATIC DISCHARGE: This icon indicates the possible presence of Electrostatic Discharge (ESD or “static electricity”) that may harm the internal electronic components. The user is advised to handle the device only after discharging any possible electrostatic buildup that may be present.
	NOTE: This icon identifies information that relates to the safe operation of the equipment or related items.
	TIP: This icon identifies helpful hints and tips.

REVISION HISTORY

Revision Status Summary Sheet

Revision	Date	Sheet(s) Affected
0.1	09/01/2006	Initial release. Title, all sheets.
0.2	12/07/2006	Page 34 - Updated Ordering Information table.
0.3	03/07/2007	All. Preliminary technical review.
0.4	04/02/2007	All. Datasheet reorganized.
1.0	04/20/2007	Official release.
1.1	04/25/2007	Page 40 - added User-Addressable LBA Sector value for 48GB SSD in Table 11 under "Storage Capacities" topic.
1.2	06/11/2007	Page 16 - removed SATA connector artwork (Figure 2) and updated figure references; Page 20 - "ATA Command Flow" topic corrected; Page 49 - updated "Operating Temperatures" table (Table 15); Page 50 - edited "Altitude Parameters" topic; Page 52 - minor edit to Paragraph 4 of "Conformal Coating" topic, "some component topsides"; Page 54 - minor edit to Table 22; Page 56 - added "Primary Heat Generation Area" topic.
1.3	06/15/2007	Minor spelling and grammatical corrections throughout datasheet. Page 46 - updated Table 13 to include 12 and 96 gigabyte user-addressable LBA sectors.
1.4	06/28/2007	Page 62 - removed "Firmware Upgrades" topic.
1.5	07/09/2007	All - removed all references to "2,000,000 write/erase cycles". Minor grammar and spelling corrections.

TABLE OF CONTENTS

Conventions	iii
Revision History	v
List of Figures	xv
List of Tables	xvii
Scope	1
Manual Overview	1
Audience	1
Standards and Reference Documents	2
Standard Features and Optional Features	2
Product Description	2
Performance Characteristics	2
Electrical Specifications	2
Interface Specifications	2
Physical Characteristics	2
Environmental Characteristics	2
Installation	2
Regulatory Compliance	2
Standards and Reference Documents	3
Electromagnetic Susceptibility	3
Electromagnetic Compatibility	3
Military Information Systems Security Standards	3
Commercial Standards	4
Reference Documents	4
Standard Features	5
Interface	5
Performance	5
Unformatted Capacities	5
Endurance	5
Reliability	5
Physical Characteristics	6
Environmental Characteristics	6

Compliance	6
Power	7
Optional Features	7
Optional Purge Features.....	7
Optional Environmental Features	7
Manufacturing	7
Product Description	8
General Description.....	8
SATA Interface	8
Drive Capacities	8
Performance	8
Data Security	8
Performance Characteristics	9
Endurance	9
Wear-Leveling Algorithm	9
Bad-Block Management	9
Data Retention.....	9
Reliability	10
Error Rates	10
Erase Cycles.....	10
Error Detection and Error Correction	10
Built-In Self Test (BIST)	10
ATA Modes	10
Mount Time	11
Seek Time.....	11
Data Transfer Rates	11
Cache Operations.....	11
Purge Times	12
Repairs	12
Preventative Maintenance	12
Hot Plugging Drive	12

Electrical Specifications	13
Power Requirements	13
Power Consumption	13
Activity LED Indicator	13
Drive Power-On Ready Time	14
Power Saving Commands	14
Power Mode at Power On	14
Grounding	14
Hardware Purge	14
Interface Specifications	15
SSD Operation	15
Functional Blocks	16
SATA Interface Block	16
SSD Control Block	19
ATA Commands	20
ATA Command Flow	20
Standard ATA Commands	21
Standard ATA Command Summary	23
Check Power Mode (98h or E5h)	23
Download Microcode (92h)	23
Erase Sector (C0h)	23
Execute Drive Diagnostic (90h)	23
Flush Cache (E7h)	23
Flush Cache Extended (EAh)	23
Format Track (50h)	24
Identify Response (ECh)	24
Idle (97h, E3h)	24
Idle Immediate (95h, E1h)	24
Initialize Drive Parameters (91h)	24
NOP (00h)	24
Read Buffer (E4h)	24
Read DMA (C8h)	24

Read DMA Ext (25h).....	24
Read DMA Queued (C7h)	25
Read DMA Queued Ext (26h).....	25
Read Multiple (C4h).....	25
Read Multiple Extended (29h)	25
Read Sector(s) (20h)	25
Read Sector(s) Extended (24h).....	25
Read/Verify Sector(s) (40h)	25
Read/Verify Extended (42h)	25
Recalibrate (10h)	26
Security Disable Password (F6h)	26
Security Erase Prepare (F3h)	26
Security Erase Unit (F4h)	26
Security Freeze Lock (F5h)	26
Security Set Password (F1h)	26
Security Unlock (F2h)	26
Seek (70h, 7Fh)	27
Set Features (EFh)	27
Set Multiple Mode (C6h)	27
Set Sleep Mode (99h or E6h)	27
Sleep (E6h)	27
SMART (B0h)	27
Standby (96h or E2h).....	27
Standby Immediate (94h or E0h).....	28
Write Buffer (E8h)	28
Write DMA (CAh)	28
Write DMA Ext (35h).....	28
Write DMA FUA Ext (3Dh).....	28
Write DMA Queued (CCh)	28
Write DMA Queued Ext (38h)	28
Write DMA Queued FUA Ext (3Eh)	28
Write Multiple (C5h).....	29

Write Multiple Ext (39h).....	29
Write Multiple FUA Ext (CEh)	29
Write Sector(s) (30h).....	29
Write Sector(s) Ext (34h)	29
SMART Support.....	30
SMART Commands	30
SMART Attributes	31
Identify Response Information	31
Vendor-Specific ATA Commands	44
Sanitize Erase/Fill	44
Sanitization Standards	45
Physical Characteristics	46
General Physical Characteristics	46
Materials	46
Drive Assembly Weight	46
Storage Capacities.....	46
Exterior Dimensions.....	47
SATA Connector Location	48
Environmental Characteristics	49
Overview	49
Operating Temperatures.....	49
Operating Requirements.....	49
Non-Operating Requirements	50
Relative Humidity	50
Altitude Parameters	50
Restriction of Hazardous Materials	51
Shock and Vibration.....	51
Failure Criteria	51
Random Vibration	51
Shock	51
Drop Testing	52
Conformal Coating	52

Installation	53
System Requirements	53
SATA Connections	53
Drive Configuration	53
Connector Requirements.....	54
Drive Orientation	55
Primary Heat Generation Area	56
Cooling Requirements	57
Installation Dimensions.....	58
Mounting Requirements.....	59
Drive Installation	60
Grounding Requirements.....	60
Operating System Specifications.....	61
Microsoft OS Compatibility	61
Alternative Operating Systems	61
System POST, Boot and Resume Times	61
NAND Flash Support	61
Diagnostic Software.....	61
Regulatory Compliance	62
Marking, Approvals and Supporting Documentation	62
CB Certificate and CB Report.....	63
Declaration of Conformity	63
Radio Frequency Emissions.....	64
Radio Frequency Immunity Requirements	64
EMI Test Site Correlation.....	64
Verification Samples	64
Verification Testing	64
Electrostatic Discharge (ESD)	65
Acceptance Criteria Definitions.....	65

Contact and Ordering Information	.66
Contact Information.....	66
Ordering Information.....	66
Acronyms and Abbreviations	.67
Index	.71
Certification and Warranty	Inside Back Cover

LIST OF FIGURES

1.	The Zeus 2.5-Inch SATA Solid State Drive	1
2.	SATA Signal Segment.....	16
3.	SATA Power Segment.....	17
4.	Zeus 2.5-inch SSD Assembly Dimensions	47
5.	SATA Connector Location	48
6.	Possible Drive Orientations	55
7.	Primary Heat Generation Area	56
8.	Suggested Air Flow Patterns for Cooling.....	57
9.	Exterior Mounting Dimensions.....	58
10.	Mounting Hole Requirements	59

LIST OF TABLES

1. Error Limits	10
2. Data Transfer Rates	11
3. Purge Times	12
4. Zeus SATA Absolute Power Requirements.....	13
5. SSD Typical Power Consumption.....	13
6. SATA Connector Signal Definitions	17
7. SATA Connector Power Segment Definitions	18
8. Supported ATA Commands.....	21
9. SMART Command Values.....	30
10. Supported SMART Attributes	31
11. Identify Response Information	32
12. Sanitize Standards Compliance.....	45
13. Zeus SSD Capacities.....	46
14. 2.5 Drive Assembly Dimensions	47
15. Operating Temperatures.....	49
16. Non-Operating Conditions	49
17. Non-Operating Conditions	50
18. Relative Humidity Operating Criteria	50
19. Operating and Non-Operating Altitudes.....	50
20. Random Vibration Levels.....	51
21. Shock Test Results.....	51
22. Recommended FPC Mating Specifications	54
23. Regulatory Marks and Documentation	62
24. EMI Specification Limits.....	64
25. ESD Requirements	65
26. Acceptance Criteria Definitions.....	65

SCOPE



Figure 1. The Zeus 2.5-Inch SATA Solid State Drive

Manual Overview

This datasheet describes the applications, specifications, and installation of the Zeus 2.5-inch Serial ATA (SATA) Solid State Drive (SSD). See *Figure 1*. The contents of this datasheet can be quickly ascertained by reviewing the abstracts described under the [Scope](#) section.

Audience

This manual is intended for system engineers or system designers employed by an Original Equipment Manufacturer (OEM). This datasheet was therefore written specifically for a technically advanced audience; it is not intended for end-users that will eventually purchase the commercially available product. The **user**, as referenced throughout the manual, is primarily concerned with industrial, commercial or military applications.

Standards and Reference Documents

This section discusses the formal standards that apply the Zeus 2.5-inch SATA SSD, including electrical product standards and military information systems security standards. In addition, this section lists the reference documents relevant to the ATA interface protocol used for the Zeus 2.5-inch SATA SSD.

Standard Features and Optional Features

These two sections list the standard and optional features of the 2.5-inch SATA SSD.

Product Description

This section provides a general description of the SSD, and includes media, performance, reliability and capacity information.

Performance Characteristics

This section describes the internal and seek characteristics of the SSD and includes information on the access execution times.

Electrical Specifications

This section describes the power requirements and power consumption parameters of the SSD and includes explanations of power saving commands supported by the drive.

Interface Specifications

This section provides a table of the connector pinout and tables of the electrical characteristics for the pin signals. In addition, this section describes how the drive uses the pin signals when interacting with the host system. There is also a listing of the ATA commands supported by the Zeus SSD.

Physical Characteristics

This section describes the general physical parameters of the SSD, the weight of the finished assembly, available storage capacities, the exterior dimensions and the location of the SATA connector.

Environmental Characteristics

This section provides the various temperature and relative humidity conditions, and the shock and vibration conditions during the testing of the SSD.

Installation

This section discusses issues relating to the installation of the 2.5-inch SSD in a PC or other enclosure, including cooling and grounding.

Regulatory Compliance

This section provides an overview of the marking, approval, documentation and reporting conventions for the SSD.

Standards and Reference Documents

This section discusses the various standards for electronic products, electronic equipment, military use and how those standards apply to the Zeus 2.5-inch SATA SSD.

Electromagnetic Susceptibility

The Zeus 2.5-inch SATA SSD is intended for installation by the user in an appropriate enclosure, i.e., a PC or alternate enclosure. The enclosure must be designed so that the use of the Zeus drive does not impair nearby electronic equipment within the same enclosure and external to the enclosure.

The user, as previously defined under the **Audience** section, is responsible for choosing, designing and testing the enclosure so that it is appropriate as previously defined, and complies to related regulations, such as Subpart B of Part 15 of FCC Rules and Regulations, and Radio Interference Regulations of the Canadian Department of Communications.

Electromagnetic Compatibility

Independent laboratories are in the process of confirming that the Zeus 2.5-inch SATA SSD meets the requirements for CE Marking. Test systems confirming the CE Marking may include the following:

- A current microprocessor
- 3.5-inch floppy diskette drive
- Keyboard
- Monitor
- Printer
- External modem
- Mouse

While the drive may have CE Marking, the OEM must confirm CE Marking for the product in which the drive has been integrated.

Military Information Systems Security Standards

The following military standards apply to the Zeus 2.5-inch SATA SSD:

- DoD 5220.22-M
- NSA 130-2
- AFSSI 5220
- AR380-19
- Navso-P 5239, NEBS Level 3

Commercial Standards

Zeus SSDs comply, in whole or in part, with the following commercial standards:

- S/NZS 3548 Class B
- BSMI CNS 13438 Class B
- CAN/CSA-V3/2001.04 (VCCI)
- CE (Conformite Europeenne)
- CISPR 22 Class B
- EN 55022 Class B
- EN 61000-3-2
- EN 61000-3-3
- FCC Part 15 Class B
- Underwriters Laboratories (UL)
- NEBS Level 3
- IEC 61000-4-2
- IEC 61000-4-3
- IEC 61000-4-4
- IEC 61000-4-5
- IEC 61000-4-6
- IEC 61000-4-8
- IEC 61000-4-11

Reference Documents

The following list of ANSI documents are relative to the Zeus 2.5-inch SATA SSD:

- NCITS T13 Project 1697D AT Attachment - 8 ATA Serial Transport (ATA8-AST)
- NCITS 1699D AT Attachment 8 - ATA/ATAPI Command Set (ATA8-ACS)
- NCITS 1510D Host Adapter Standards (ATA Adapter)

Standard Features

Interface

- Serial ATA (SATA) 1.0 with intended compliance to future SATA 2.0 standard
- Point-to-point connection
- Interface bandwidth 150 Mbytes/sec (300 Mbytes/sec with future SATA 2 standards)

Performance

- Fast initialization
- Burst Transfer Rate: 1.5 Gbits/sec
- Sustained Read/Write: Up to 55 MB/s
- Latency, Average: 0.5 msec

Unformatted Capacities

- 8GB to 128GB

Endurance

- Wear-leveling algorithms
- Bad-block mapping algorithms
- Supports unlimited read cycles

Reliability

- Solid state design
- Data integrity: 10-year data retention
- Manual and automatic self-diagnosis tests
- Embedded EDC/ECC (Error Detection and Error Correction)
- Dependable operation under unstable power conditions
- Rugged, impact-resistance casing
- 5 year warranty

Physical Characteristics

- Industry standard 2.5-inch form factor, precision machined aluminum alloy enclosure
- Compact design: 100.2 mm (L) x 69.8 mm (W) x 9.5 mm (H)
- 8 to 128 gigabyte unformatted capacities
- Weight: < 0.4 kg
- SATA connector: 7-pin signal segment, 15-pin power segment

Environmental Characteristics

- Two Operating Temperature ranges available:
 - Commercial range: 0°C to 70°C
 - Industrial range: -40°C to 85°C
- Storage Temperature of -55°C to 95°C
- Humidity of 5% to 95% relative, non-condensing
- Operating Altitude of 80,000 feet

Compliance

- Meets NEBS Level 3 requirements for telco electrical environments
- Meets U.S. Army, Navy, Air Force and DoD security erase and sanitization (purge) guidelines
- Meets UL 1950 requirements for Electrical Equipment sold in the United States of America and is marked accordingly
- Compliance with CSA CAN/CSA-C22.2, No. 950-M89 requirements for Electrical Equipment sold in Canada and is marked accordingly.
- Compliance with European Community (European Union) Information Technology Equipment (ITE) directives.
- MIC (Korean) certified.
- BSMI (Taiwan) certified.
- VCCI (Japan) certified.
- C-Tick (Australia) certified.
- FCC Declaration of Conformity (DoC)

Power

- Input voltage: 5V DC +/-5%
- Typical consumption:
 - Standby: 300mW
 - Idle: 550mW
 - Sustained Read/Write: 2.1W

Optional Features

- SMART Status Monitoring (See "SMART Support")
- Sanitization (See "Sanitize Erase/Fill")

Optional Purge Features

- BasicPurge™: Erases solid state drive
- RapidPurge™: Erases solid state drive in seconds
- MilPurge™: Erases solid state drive in compliance with security guidelines (DoD 5220.22-M, NSA 130-2 AFSSI 5020, AR 380-19 and Navso 5239)
- Intelligent Destructive Purge™: Physically damages the flash media, making it totally unusable as media
- Hardware Purge

Optional Environmental Features

- Conformal coating

Manufacturing

- Santa Ana, California
United States of America
- ISO 9001 Certified

PRODUCT DESCRIPTION

General Description

The Zeus 2.5-inch Serial ATA (SATA) Solid State Drive (SSD) is a non-volatile mass storage device. The SSD is a replacement for a standard ATA-compliant hard disk drive (HDD). No additional device drivers are required, and the drive can be configured as a boot or data storage device.

SATA Interface

The SSD can be installed in any operating system environment that supports SATA 1.0 or greater devices. The drive is compliant with SATA 2 standards. The SSD supports all ATA and ATAPI devices. The SSD has a standard Serial ATA interface that is fully ATA/ATAPI-8 compliant and conforms to the same mechanical and mounting requirements as a standard rotating disk drive.

Drive Capacities

The SSDs are available with unformatted memory capacities of 8, 12, 16, 24, 32, 48, 64, 96 and 128 gigabytes. The memory is comprised of NAND Single-Level Cell (SLC) EEPROM flash components. In addition, the SSDs are configured with a cache buffer of 64 megabytes.

Performance

Zeus SATA SSDs can operate at sustained read/write transfer rates of up to 55 megabytes per second. Power consumption is kept to a minimum; SSDs can be powered from a single 5-volt source. The solid state design eliminates electromechanical noise and delay inherent in traditional magnetic rotating media. The wear-leveling and bad-block mapping algorithms ensure consistency, accuracy, and integrity of user data. The non-recoverable error rate of Zeus SATA SSDs is less than 1 error per 10^{20} bits read.

Data Security

The SSD offers optional data sanitization (purge) features that can be customized by the user. Supporting both sanitized erase/fill and non-recoverable sanitization options, The SSDs can be configured to remove data from the drive, freeing storage space for later reuse, or to remove data and destroy the storage media, making the SSD unusable and data retrieval impossible. The data security features comply with Department of Defense (DoD) and US military data security standards, including AFSSI 5020, AR 380-19, NAVSO P-5239-26, NISPOM DoD 5220.22-M and NSA 130-2.

PERFORMANCE CHARACTERISTICS

Endurance

The useful life of flash media is limited by the number of write/erase operations that can be performed on the media. To extend the useful life of Zeus SSDs, special wear-leveling and bad-block mapping algorithms are integrated in the firmware.

Wear-Leveling Algorithm

The dynamic wear-leveling algorithm integrated in the firmware guarantees that erase/write cycles are evenly distributed across all of the flash memory block locations. Wear-leveling eliminates repeated writes to the same physical flash memory location, thereby preventing blocks from premature wear.

Bad-Block Management

The bad-block mapping algorithm replaces bad-blocks with new ones from available spares. Two percent (2%) of the flash memory is held in reserve (spare blocks) for bad block replacement. Bad blocks in the media are flagged when detected. The next time an attempt is made to access a flagged block, it is immediately replaced by a spare block. The bad-block mapping function enables data to be automatically transferred from a bad sector to an available spare block.

Notes:

- 1 STEC Inc. scans for bad blocks during the manufacturing process at the initial installation of the flash components. Bad blocks are mapped and identified during the manufacturing process.
- 2 The maximum amount of available user space will not be less than 97% of the total flash capacity, i.e., the reserved space will not exceed more than 3% of the total drive volume.

Data Retention

Data stored on Zeus SSDs remains valid for 10 years without requiring power support. The unit can be stored under certain environmental conditions for extended periods without any occurrence of data degradation.

Reliability

Error Rates

Table 1 lists the error limit specifications. When all data correction mechanisms are enabled, the error rate will be sustained through all operating temperature ranges as specified in the upcoming sections.

Table 1. Error Limits

Error Type	Maximum Number of Errors
Recoverable Data Error	1 bit in 10^{20}
Unrecoverable Data Error	Less than 1 bit in 10^{20}

Erase Cycles

The drive design implements the a wear-leveling algorithm to enhance the life of the flash. The SSDs maintain at least 2 million erase cycles over the entire flash. The wear-leveling algorithm ensures the entire volume is cycled, including the static and the dynamic data.

Error Detection and Error Correction

The Error Detection Code and Error Correcting Code (EDC/ECC) helps maintain data integrity by allowing single or multiple bit corrections to the data stored in the flash array. If the data in the flash array is corrupted due to aging or during the programming process, EDC/ECC will compensate for the errors to ensure the delivery of accurate data to the host computer. The EDC/ECC engine is capable of correcting up to four (4) bytes in error and detecting up to five(5) bytes in error. An extensive retry algorithm is also implemented on all Zeus SATA SSDs, so that single event disturbances such as ESD or EMF occurring during a read operation can be readily overcome.

Built-In Self Test (BIST)

The micro-controller tests the controller memory during power-up, and then performs a back-end status check to verify proper flash memory controller operations. If a fault condition is detected in the flash memory controller, the status of the SSD is reported as failed.

ATA Modes

The Zeus 2.5-inch SATA SSD supports the following ATA operating modes:

- PIO Modes 0 through 4
- UDMA Modes 0 through 5
- Serial ATA 2.0 (1.5Gb)

Mount Time

The amount of time required to initialize and mount a Zeus SATA SSD varies according to the operating system (Windows®, Linux®, etc.) in which the SSD is running and the storage capacity of the drive.

Seek Time

Unlike a magnetic rotating disk, the SSD has no read/write heads or platter. There is no seek time or rotational latency issues. Zeus SSDs dramatically improve transaction throughput, particularly for applications that are configured to take advantage of the characteristics of the drive.

Data Transfer Rates

The data transfer rate of the SSDs depends on the flash controller/flash memory configuration of the drive. The scalable architecture of the drive is capable of accommodating sustained and burst data transfer rates outlined in *Table 2*.

Table 2. Data Transfer Rates

Transfer Rate	Drive Capacities	
	8 - 64 GB	80 - 128 GB
Burst Transfer Rate	1.5Gb/s	1.5Gb/s
Sustained Read Throughput	40MB/s	55MB/s
Sustained Write Throughput	26MB/s	55MB/s

Cache Operations

The SSD is configured with 64Mbytes of usable cache. The drive will track the location of the data stored in the cache, and will use the cache data instead or re-transferring the data from the host or the media, if the cache contains the data needed for read or write.

A two-way set associative cache algorithm is implemented using 128Kbyte line sizes. The cache operation is circular, and when the end of the segment is addressed, it will wrap around to the beginning location of the segment.

The cache buffer can be accessed directly using the Write Buffer (0xE8) command. The cache is enabled or disabled using the ATA Set Features (0xEF) command. The Read and Write cache are both enabled by default.

Purge Times

The time required to purge a Zeus SSD depends on the actual purge option invoked by the user and the flash controller/flash memory configuration of the drive. A list of approximate purge times is listed in *Table 3*, with the value expressed in seconds per 32 Gigabytes (s/32GB) for each purge option.

Table 3. Purge Times

Purge Option	Value	Units
BasicPurge	360	s/32GB
RapidPurge	9	s/32GB
MilPurge	1,200	s/32GB
Intelligent Destructive Purge	2	s/32GB

Repairs

A defective SSD should be replaced. There are no parts, assemblies or subassemblies that can be repaired individually by the user. Please see the section titled **Certification and Warranty** on the inside of the back cover page. *Unauthorized repairs to the SSD will void the warranty.*

Preventative Maintenance

No preventative maintenance is required. The drive is sealed at the factory, and there are no parts, assemblies or subassemblies that require preventive maintenance on behalf of the user. Please see the section titled **Certification and Warranty** on the inside of the back cover page. *Unauthorized maintenance to the SSD will void the warranty.*

Hot Plugging Drive

The SSD can be inserted or removed during operation. This capability is known as “hot plugging”. The error recovery procedures will recover from any errors introduced by hot plugging. The method used by the system to detect the insertion/removal of the SSD is dependent upon the scenario. For example, the backplane may be powered, but the SSD may be in a “quiescent” state. It is recommended that the user reference the Serial ATA 2.6 Specification (SerialATA International Organization (SATA-IO), High-Speed Serialized ATA Attachment, February 2007) for an overview of the terms and scenarios associated with “hot plugging” serial drives.

- 1 Hot plugging under the SATA 2.0 standard is limited to backplane applications and connections; the SSD cannot be connected/disconnected for cabled applications.
- 2 The user should avoid hot plugging a SSD that has been configured as a boot drive. Unrecoverable errors may be introduced by the operating system if the user attempts to remove/install a SSD with an OS installed on it.

ELECTRICAL SPECIFICATIONS

Power Requirements

The SSD requires a 5V power source. If a power failure occurs, the drive design ensures that the data contained in the storage memory is preserved. Data loss or corruption does not occur.

Table 4. Zeus SATA Absolute Power Requirements

Symbol	Description	Rating	Unit	Note
VDD	DC Supply Voltage	-0.3 to +6.0	V	
VIN	Input Voltage	-0.5 to +5.5	V	5-volt tolerant
VOUT	Output Voltage	-0.5 to 3.8V	V	
IDD	DC Current	1,100	mA	Purge
TSTG	Storage Temperature	-55 to +95	°C	

Power Consumption

The amount of power consumed by Zeus SATA SSDs is determined by the storage (memory) capacity of the drive, and the flash controller/memory configuration of the drive. See *Table 5*.

Table 5. SSD Typical Power Consumption

Operation	Power Consumption
Standby	300mW
Idle	550mW
Read (40MB/sec)	2.1W
Write (40MB/sec)	2.1W

Activity LED Indicator

Zeus Serial ATA SSDs are configured to drive Pin 11 of the Serial ATA cable during all command activity and during periods when the drive indicates a busy state. See *Power Segment Pinout Configuration*.

Drive Power-On Ready Time

The power-on ready time for the SSD is less than 2.5 seconds. Power-on ready time is measured from the time the drive is powered on to the time the drive is ready to accept the first command from the host.

Power Saving Commands

Zeus SSDs support the following Power Savings commands and respond with the appropriate status:

- Check Power Mode
- Idle
- Standby
- Standby Immediate
- Sleep

The drives comply with all specifications that define the behavior of storage devices as it relates to power management and advanced power management (APM).

When the SSDs receive a power management command, all data in the write cache buffer is written to the media before drive ready is asserted.

Power Mode at Power On

The Zeus SSDs comply with the latest ATA Power Management Specification. During the Power On Reset sequence, the drive functions properly and responds as appropriate. In addition, if a SRST (ATA Interface Reset) occurs during this sequence, the drives still respond normally. The drives goes into IDLE or STANDBY mode, depending on the setting by the host, after power on or hard reset.

Grounding

Signal and chassis grounds are not connected together in the drive. To ensure minimal EM emissions, the user should provide maximum surface contact area when connecting the drive to the chassis ground.

Hardware Purge

A voltage can be applied to Pin 13 to invoke a hardware purge. The user can employ a software utility to preset whether BasicPurge™, RapidPurge™, MilPurge™, or Intelligent Destructive Purge™ is used when a voltage is applied to Pin 13. See [Power Segment Pinout Specification](#).

INTERFACE SPECIFICATIONS

SSD Operation

The Zeus SATA SSD is comprised of three primary functional blocks: the SATA interface connector, Zeus controller and NAND flash memory. A description of each drive component is provided under *Functional Blocks*.

Read/Write data transfer requests are initiated by the host via the SATA bus interface. Once received, the Zeus controller, under the direction of the microcontroller, processes the request.



The microcontroller is responsible for initiating and controlling all activity within the controller, including bad block mapping and executing the wear-leveling algorithms.



The Zeus controller decodes an incoming host command, and will configure the appropriate interrupts and status for the local microprocessor to handle various commands. For read and write transfer commands, the hardware can handle the initial handshake with the host automatically. If firmware enables full auto mode, read and write transfers can be fully handled by hardware with minimum firmware support.

Commands that do not require data to be read from or written to the flash memory controller are typically handled by the Zeus controller. Some commands may require the Zeus controller to use external circuitry (for example, Intelligent Destructive Purge™), that do not involve the flash memory controller.

When a write operation is requested and data is received, the controller uses integrated DMA controllers to transfer the data from host memory to the flash memory controller. Through a standard ATA (IDE) interface, the flash memory controller transfers the data from the Zeus controller to available locations in the local flash memory of the SSD. The internal transfer rates can range up to 55MB/s. The controller notifies the host after the write operation is completed.

If a read request is received, the controller retrieves the data from the local flash memory via the flash memory controller. If the controller is responding to a PIO read operation, it presents the data to the ATA bus. If it is responding to a UDMA read request, the controller writes the data directly to the system memory on the host. Regardless of the type of operation (PIO or UDMA), the Zeus controller notifies the host when the data is ready for transmission.

Functional Blocks

The Zeus SATA SSDs comprise the following primary functional component blocks:

- SATA Interface Block
- SSD Control Block
- NAND Flash Memory

SATA Interface Block

This section provides information on the SATA connector of the Zeus SSD.

SATA Interface Connector

The connector on Zeus SATA SSDs is divided into a *Signal Segment* (S1 - S7) and a *Power Segment* (P1 - P15). The connector supports the signal and power segments cabled up to 1 meter (39 inches) and backplane connections. The connector is designed to blind mate, has staggered contacts to facilitate "hot plugging", and supports the future 3.0 Gb/sec speed. See *Figure 2*.

Signal Segment Pinout Configuration

A SATA signal cable uses a protocol transmitted over a 7-pin cable, versus the current IDE 40/80 conductor cable. *Figure 2* identifies the 7-pin signal segment of the cable. *Table 6* lists the signal definitions of the 7-pin segment.

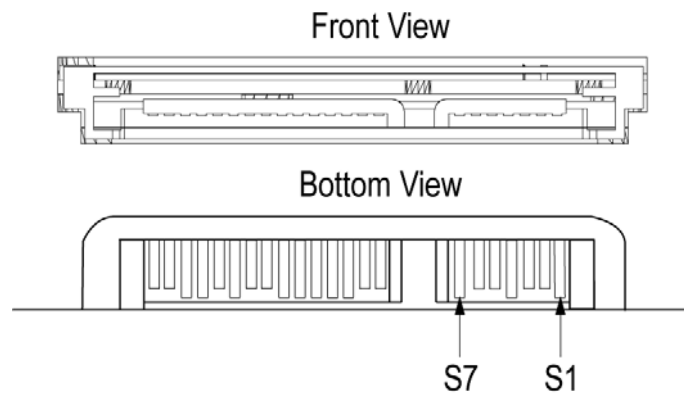


Figure 2. SATA Signal Segment

The 7-pin signal segment of the SATA connector includes 3 grounds, 2 transmit, and 2 receive pins. The transmit pins are TxN 5 and TxP 6 and the receive pins are RxP 2 and RxN 3. *This pin configuration is reversed on the host plug; Pins 2 and 3 are the transmit pins and 5 and 6 are the receive pins.*

Table 6. SATA Connector Signal Definitions

Pin	Signal Name	Signal Description
S1	Ground	Second Mate
S2	RxP	+Differential Receive Signal
S3	RxN	-Differential Receive Signal
S4	Ground	Second Mate
S5	TxN	+Differential Transmit Signal
S6	TxP	-Differential Transmit Signal
S7	Ground	Second Mate

Power Segment Pinout Configuration

The SATA power connector consists of 15 pins. *Figure 3* identifies the 15-pin power segment of the cable. *Table 7* lists the signal definitions of the 15-pin segment. The system power supply must deliver a 5V voltage. Pin 11 is reserved to drive the Activity LED indicator.

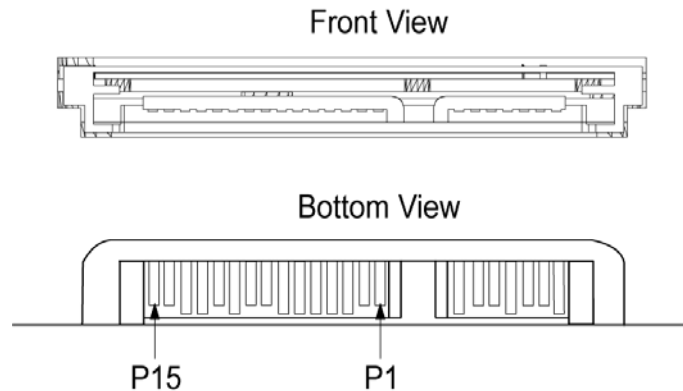


Figure 3. SATA Power Segment



To install the Zeus SATA SSD on legacy systems equipped with an add-in SATA controller requires a power adapter cable to convert a traditional power connector to a SATA power connector.

Table 7. SATA Connector Power Segment Definitions

Pin	Signal Name	Signal Description
P1	V3.3	3.3V Power (Not Used)
P2	V3.3	3.3V Power (Not Used)
P3	V3.3	3.3V Power (Not Used)
P4	Ground	First Mate
P5	Ground	Second Mate
P6	Ground	Second Mate
P7	V5	5V Power, Pre-charge, Second mate
P8	V5	5V Power
P9	V5	5V Power
P10	Ground	Second Mate
P11	Reserved	Drive Activity Indicator (Activity LED)
P12	Ground	First Mate
P13	V12	12V Pre-charge (Hardware Purge)
P14	V12	12V Power (Not Used)
P15	V12	12V Power (Not Used)

SSD Control Block

The control block of the Zeus SSD is comprised of three integrated components:

- FPGA Controller
- RISC Microcontroller
- NAND SLC Flash Memory

FPGA Controller

The Field Programmable Gate Array (FPGA) Controller provides the interface between the SATA drive and the host, and the IDE interface to the local flash memory installed in the drive. The integrated DMA controller interfaces with the system memory to facilitate data transfer between the host and local flash memory of the SSD.

RISC Microcontroller

An integrated microcontroller initiates and controls all activity within the Zeus ATA controller. The microcontroller features more than 1 Mbit of on-chip SRAM and a wide range of peripheral functions, with 8 Mbits of flash memory into a single 120-BGA package. The embedded microcontroller is a high-performance processor with a high-density instruction set with very low power consumption. In addition, a large number of internally banked registers provide very fast exception handling, making it ideal for the real-time application control requirements of the SSD. The 8-level priority-vectorized interrupt controller, together with the Peripheral Data Controller, significantly enhance the real-time performance of the SSD.

The flash memory controller architecture requires only minimal external component support. The flash controller works with flash memory devices from Samsung® and Toshiba®, as well as a number of compatible flash memory devices from other manufacturers.

Features of the flash memory controller include:

- Built-in 3.3V voltage regulator for flash memory supply
- Data transfer rates up to 55 MB/sec (controller to flash memory)
- True-IDE mode support
- Embedded ECC unit
- Wear-leveling and bad-block mapping software

NAND SLC Flash Memory

The local subsystem uses Single-Level Cell (SLC) NAND, non-volatile flash memory that has only two states and one bit of stored data. The SLC NAND flash control logic on the SSD is able to conserve energy when managing the electrical charge during operation.

ATA COMMANDS

This section provides information on the ATA commands supported by the Zeus SATA SSD. The commands are issued to the ATA by loading the required registers in the command block with the supplied parameter, and then writing the command code to the register.

ATA Command Flow

DDMAI0: DMA_in State	This state is activated when the device receives a DMA data-in command or the transmission of one or more data FIS is required to complete the command. When in this state, the device shall prepare the data for transfer of a data FIS to the host.
Transition DDMAI0:1	When the device has the data ready to transfer a data FIS, the device shall transition to the DDMAI1: Send_data state.
Transition DDMAI0:2	When the device has transferred all of the data requested by this command or has encountered an error that causes the command to abort before completing the transfer of the requested data, then the device shall transition to the DDMAI2: Send_status state.
DDMAI1: Send_data	This state is activated when the device has the data ready to transfer a data FIS to the host. When in this state, the device shall request that the Transport layer transmit a data FIS containing the data. The device command layer shall request a Data FIS size of no more than 2,048 Dwords (8KB).
Transition DDMAI1:1	When the data FIS has been transferred, the device shall transition to the DMAOIO: DMA_in state.
DDMAI2: Send_status	This state is activated when the device has transferred all of the data requested by the command or has encountered an error that causes the command to abort before completing the transfer of the requested data. When in this state, the device shall request that the Transport layer transmit a Register FIS with the register content as described in the command description in the ATA/ATAPI-6 standard and the I bit set to one.
Transition DDMAI2:1	When the FIS has been transmitted, the device shall transition to the DIO: Device_idle state.

Standard ATA Commands

Table 8 lists each command along with its respective command code and registers accessed by the command. For detailed descriptions of the ATA commands, refer to the ATA-5 specification.

Table 8. Supported ATA Commands

Command	Command Code (Hex)	Feature Register	Sector Count Register	Sector Number Register	Cylinder High/Low Register	Drive/Head Number Register
CHECK POWER MODE	98h or E5h	No	Yes	No	No	Yes ^(a)
DOWNLOAD MICROCODE	92h	Yes	No	No	No	No
ERASE SECTOR	C0h	No	Yes	Yes	Yes	Yes ^(a)
EXECUTE DRIVE DIAGNOSTIC	90h	No	No	No	No	Yes ^(a)
FLUSH CACHE	E7h	TBD	TBD	TBD	TBD	TBD
FLUSH CACHE EXTENDED	EAh	TBD	TBD	TBD	TBD	TBD
FORMAT TRACK	50h	No	Yes	No	Yes	Yes ^(b)
IDENTIFY RESPONSE	ECh	Yes	No	No	No	Yes ^(a)
IDLE	97h, E3h	No	Y	No	No	Yes ^(a)
IDLE IMMEDIATE	95h, E1h	No	No	No	No	Yes ^(a)
INITIALIZE DRIVE PARAMETERS	91h	No	Yes	No	No	Yes ^(b)
NOP	00h	No	No	No	No	Yes ^(b)
READ BUFFER	E4h	No	No ^(d)	No ^(d)	No ^(d)	No ^(d)
READ DMA	C8h	No	Yes	Yes	Yes	Yes ^(b)
READ DMA EXTENDED	25h	No	Yes	Yes	Yes	Yes ^(b)
READ DMA QUEUED	C7h	No	Yes	Yes	Yes	Yes ^(b)
READ DMA QUEUED EXT	26h	No	Yes	Yes	Yes	Yes ^(b)
READ MULTIPLE	C4h	No	Yes	Yes	Yes	Yes ^(b)
READ MULTIPLE EXTENDED	29h	No	Yes	Yes	Yes	Yes ^(b)
READ SECTOR(S)	20h	No	Yes	Yes	Yes	Yes ^(b)
READ SECTOR(S) EXTENDED	24h	No	Yes	Yes	Yes	Yes ^(b)
READ VERIFY SECTOR(S)	40h	No	Yes	Yes	Yes	Yes ^(b)
READ VERIFY EXTENDED	42h	No	Yes	Yes	Yes	Yes ^(b)
RECALIBRATE	10h	No	No	No	No	Yes ^(a)
SECURITY DISABLE PASSWORD	F6h	No	No	No	No	Yes ^(a)
SECURITY ERASE PREPARE	F3h	No	No	No	No	Yes ^(a)
SECURITY ERASE UNIT	F4h	No	No	No	No	Yes ^(a)
SECURITY FREEZE LOCK	F5h	No	No	No	No	Yes ^(a)
SECURITY SET PASSWORD	F1h	No	No	No	No	Yes ^(a)

Command	Command Code (Hex)	Feature Register	Sector Count Register	Sector Number Register	Cylinder High/Low Register	Drive/Head Number Register
SECURITY UNLOCK	F2h	No	No	No	No	Yes ^(a)
SEEK	70h - 7Fh	No	No	Yes	Yes	Yes ^(b)
SET FEATURES	EFh	No	Yes	Yes	Yes	Yes ^(b)
SET MULTIPLE MODE	C6h	No	Yes	No	No	Yes ^(a)
SET SLEEP MODE	99h or E6h	No	No	No	No	Yes ^(a)
SLEEP	E6h	No	No	No	No	Yes ^(a)
SMART	B0h	Yes	Yes	Yes	Yes	Yes ^(b)
STANDBY	96h or E2h	No	Yes	No	No	Yes ^(a)
STANDBY IMMEDIATE	94h or E0h	No	No	No	No	Yes ^(a)
WRITE BUFFER	E8h	No	Yes	Yes	Yes	Yes ^(b)
WRITE DMA	CAh	No	Yes	Yes	Yes	Yes ^(b)
WRITE DMA EXTENDED	35h	No	Yes	Yes	Yes	Yes ^(b)
WRITE DMA FUA EXTENDED	3Dh	No	Yes	Yes	Yes	Yes ^(b)
WRITE DMA QUEUED	CCh	No	Yes	Yes	Yes	Yes ^(b)
WRITE DMA QUEUED EXT	36h	No	Yes	Yes	Yes	Yes ^(b)
WRITE DMA QUEUED FUA EXT	3Eh	No	Yes	Yes	Yes	Yes ^(b)
WRITE MULTIPLE	C5h	No	Yes	Yes	Yes	Yes ^(b)
WRITE MULTIPLE EXTENDED	39h	No	Yes	Yes	Yes	Yes ^(b)
WRITE MULTIPLE FUA EXT	CEh	No	Yes	Yes	Yes	Yes ^(b)
WRITE SECTOR(S)	30h	No	Yes	Yes	Yes	Yes ^(b)
WRITE SECTOR(S) EXTENDED	34h	No	Yes	Yes	Yes	Yes ^(b)

Notes:

- (a) Only drive parameters are valid.
- (b) Drive and head parameters are valid.
- (c) Address to Drive 0 (zero). When executed, both drives (Primary and Secondary) execute this command.
- (d) TBD

Standard ATA Command Summary

This section provides a summary of each supported ATA command.

Check Power Mode (98h or E5h)

The Check Power Mode command allows the host to determine the current power mode of the device. The Check Power Mode command shall not cause the device to change power or affect the operation of the Standby timer.

Download Microcode (92h)

The command allows the host to alter the microcode of the device. The data transferred using the Download Microcode command is vendor-specific. All transfers are an integer multiple of the sector size. The size of the data transfer is determined by the contents of the LBA Low register and the Sector Count register. The LBA Low register will extend the Sector Count register to create a 16-bit sector count value. The LBA Low register will be the most significant eight bits and the Sector Count register will be the least significant eight bits. A value of zero in the LBA Low and Sector Count registers specify that no data is to be transferred. This allows transfer sizes from 0 bytes to 33,553,920 bytes, in 512-byte increments. The Features register will determine the effect of the Download Microcode command.

Erase Sector (C0h)

This command will pre-erase and condition the data sectors in advance.

Execute Drive Diagnostic (90h)

This command performs the internal diagnostic tests implemented by the controller.

Flush Cache (E7h)

This command is used by the host to request the device to flush the Write cache. If there is data in the Write cache, that data shall be written to the media. The command will not indicate completion until the data is flushed to the media or an error occurs. If the device supports more than 28 bits of addressing, this command shall attempt to flush all the data in the cache. If the Write cache is disabled or is not present, the device will indicate completion without error. The command is mandatory for devices not implementing the PACKET feature set.

Flush Cache Extended (EAh)

This command is used by the host to request the device to flush the Write cache. If there is data in the Write cache, that data shall be written to the media. The command will not indicate completion until the data is flushed to the media or an error occurs. If the Write cache is disabled or is not present, the device will indicate completion without error. This command is mandatory for devices that implement the 48-bit Address feature set.

Format Track (50h)

This command writes the desired head and cylinder of the selected drive with a vendor-unique data pattern (typically 00h or FFh). The drive accepts a sector buffer of data from the host to follow the command with the same protocol as the Write Sector(s) - 30h command, although the information in the cache is not used.

Identify Response (ECh)

This command allows the host to receive parameter information from the drive.

Idle (97h, E3h)

This command will cause the drive to set BSY, enter the IDLE mode, clear BSY, and generate an interrupt. If the sector count is zero, the automatic power down mode is disabled.

Idle Immediate (95h, E1h)

This command will cause the drive to set BSY, enter the IDLE (READ) mode, clear BSY, and generate an interrupt.

Initialize Drive Parameters (91h)

This command will enable the host to set the number of sectors per track and the number of heads per cylinder.

NOP (00h)

This command is mandatory for devices that implement the PACKET and TCQ feature sets. The device will respond with command aborted. For devices that implement the TCQ feature set, the subcommand 00h in the Feature field shall abort any outstanding queue. Subcommand codes 01h through FFh in the Feature field shall not affect the status of any outstanding queue.

Read Buffer (E4h)

This command is optional for devices that do not implement the PACKET feature set. The command will enable the host to read a 512-byte block of data. The Write Buffer (E8h) command should precede the Read Buffer (E4h) command, lest the data returned be indeterminate.

Read DMA (C8h)

This command is mandatory for devices that do not implement the PACKET feature set. The command will allow the host to read data using the DMA data transfer protocol.

Read DMA Ext (25h)

This command is mandatory for devices that implement the 48-bit Address feature set. The command will allow the host to read data using the DMA data transfer protocol.

Read DMA Queued (C7h)

This command is mandatory for devices that implement the TCQ feature set. The command is similar in function to the Read DMA (C8h) command. The device may release or execute the data transfer without performing a release if the data is ready to transfer.

Read DMA Queued Ext (26h)

This command is mandatory for devices that implement the TCQ and 48-bit feature sets. The command is similar in function to the Read DMA (C8h) command. The device may release or execute the data transfer without performing a release if the data is ready to transfer.

Read Multiple (C4h)

This command is similar to the Read Sectors(s) - 20h command. Interrupts are not generated on each sector, but on the transfer of a block that contains the number of sectors as defined by a Set Multiple Mode - C6h command.

Read Multiple Extended (29h)

This command is mandatory for all devices that implement the 48-bit Address feature set. The command will read the number of logical sectors specified in the Count field. The number of logical sectors determines the DRQ data block count, which in turn will determine the number of logical sectors that are to be transferred.

Read Sector(s) (20h)

This command will read from 1 to 256 sectors as specified in the Sector Count Register. A sector count of 0 (zero) requests 256 sectors. The transfer will begin at the sector specified in the Sector Number Register.

Read Sector(s) Extended (24h)

This command is mandatory for devices that implement the 48-bit Address feature set. This command will read from 1 to 256 to 65,536 logical sectors as specified in the Sector Count Register. A sector count of 0 (zero) will request 65,536 logical sectors. The transfer will begin at the sector specified in the LBA field.

Read/Verify Sector(s) (40h)

This command will verify one or more sectors by transferring data from the flash media to the data buffer and verifying that the ECC is correct. The command is identical to the Read Sector(s) - 20h command, except that DRQ is never set and no data is transferred to the host.

Read/Verify Extended (42h)

This command is mandatory for devices that implement the 48-bit Address feature set. The command is identical to the Read Sector(s) Extended (24) command, except that no data is transferred from the device to the host. The device will read the data stored in the media and verify that no errors exist.

Recalibrate (10h)

The SSD performs only the interface timing and register operations. When this command is issued, the SSD sets BSY and waits for an appropriate length of time, after which it clears BSY and issues an interrupt. When this command ends normally, the SSD is initialized.

Security Disable Password (F6h)

This command is mandatory for devices that implement the Security Mode feature set. The command will transfer 512 bytes of predefined data from the host. If the password selected by Word 0 matches the password that was previously saved by the device, the device shall disable Lock mode. The command will not change the Master password. The Master password is reactivated when a User password is set. The command will only complete successfully if the device is in Unlocked mode.

Security Erase Prepare (F3h)

This command is mandatory for devices that implement the Security Mode feature set. The command is issued immediately before the Security Erase Unit (F4h) command to enable device erasing and unlocking. The command prevents accidental loss of data on the device.

Security Erase Unit (F4h)

This command is mandatory for devices that implement the Security Mode feature set. The command will transfer 512 bytes of predefined data from the host. If the password does not match the password previously saved by the device, the device shall reject the command and abort it. When a Normal Erase mode is specified, the Security Erase Unit command shall write binary zeros to all user data areas. If the optional Enhanced Erase mode is specified, the device shall write predetermined data patterns to all user data areas; the current data is overwritten, including sectors that are no longer in use due to reallocation.

Security Freeze Lock (F5h)

This command is mandatory for devices that implement the Security Mode feature set. The command shall set the device to Frozen mode. Other commands that update the device Lock mode are aborted. Frozen mode can be disabled by a power-off or hardware reset. If the command is issued while the device is in Frozen mode, the command is executed and the device will remain in Frozen mode.

Security Set Password (F1h)

This command is mandatory for devices that implement the Security Mode feature set. The command will transfer 512 bytes of predefined data from the host. The data controls the function of this command, which in turn defines the interaction of the identifier and security level bits. The user can in turn set the Master or User passwords, and the security level of the device.

Security Unlock (F2h)

This command is mandatory for devices that implement the Security Mode feature set. The command will transfer 512 bytes of predefined data from the host. The data controls the function of this command, which in turn defines the interaction of the Identifier bit. If the Identifier bit is set to Master

and the current security level is high, the password is compared with the stored Master password. If the device is in maximum security level then the unlock shall be rejected. If the Identifier bit is set to User, then the device shall compare the supplied password with the stored User password. If the password comparison fails, the device shall abort the command and report a decrease in the incremental value in the unlock counter.

Seek (70h, 7Fh)

This command is effectively a NOP command to the SSD although it does perform a range check.

Set Features (EFh)

This command is used by the host to establish or select certain features supported by the drive. When the SSD receives this command, it sets BSY, checks the contents of the Features register, applies changes as necessary, clears BSY and generates an interrupt. If the value in the register does not represent a feature supported by the drive, the command is canceled with the Abort Error condition.

Set Multiple Mode (C6h)

This command enables the SSD to perform multiple read and write operations and establishes the block count for these commands.

Set Sleep Mode (99h or E6h)

This is the only command that allows the host to configure the drive for Sleep Mode. When the drive is set to Sleep Mode, the SSD clears the BSY line and issues an interrupt. The card enters Sleep Mode and the hardware or software must be reset to activate the drive.

Sleep (E6h)

This command is mandatory for devices that implement the Power Management feature set. The command will cause the device to enter Sleep mode. The device will not power-on in Sleep mode nor remain in Sleep mode following a reset sequence. The method used to deactivate Sleep mode is transport specific. The Power Management feature set is mandatory for devices that do not implement the PACKET Command set. This command is mandatory when power management is not implemented by the PACKET Command set device.

SMART (B0h)

See *SMART Support*.

Standby (96h or E2h)

This command will configure the drive for Standby Mode. If the Sector Count Register is a value other than 0H, an Auto Power Down is enabled and when the drive returns to Idle Mode, the timer starts a countdown. The time is set in the Sector Count Register.

Standby Immediate (94h or E0h)

This command will cause the SSD to set BYS, enter the Standby Mode, clear BSY, and return the interrupt immediately.

Write Buffer (E8h)

This command is optional for devices that implement the General feature set. This command allows the host to write the contents of one 512-byte block of data in the buffer of the device.

Write DMA (CAh)

This command is mandatory for devices that implement the General feature set. The command allows the host to write data using the DMA data transfer protocol.

Write DMA Ext (35h)

This command is mandatory for devices that implement the 48-bit Address feature set. The command allows the host to write data using the DMA data transfer protocol.

Write DMA FUA Ext (3Dh)

This command is mandatory for devices that implement the 48-bit Address feature set. The command provides the same function as Write DMA Extended (35h) regardless of whether write caching is enabled. The user data is written to the media before ending status for the command is reported.

Write DMA Queued (CCh)

This command is mandatory for devices that implement the TCQ feature set. The command is similar to the Write DMA (CAh) command. The device may perform a release or may execute the data transfer without performing a release if the data is ready to transfer. If the device performs a release, the host should reselect the device using the SERVICE command. Once the data transfer has begun, the device shall not perform a release until the entire data transfer is complete.

Write DMA Queued Ext (38h)

This command is mandatory for devices that implement the TCQ and 48-bit Address feature sets. The command is similar to Write DMA Extended (35h). The device may perform a release or may execute the data transfer without performing a release if the data is ready to transfer. If the device performs a release, the host should reselect the device using the SERVICE command. Once the data transfer has begun, the device shall not perform a release until the entire data transfer is complete.

Write DMA Queued FUA Ext (3Eh)

This command is mandatory for devices that implement the TCQ and 48-bit Address feature sets. The command is similar to the Write DMA Extended (35h) command. The device may perform a release or may execute the data transfer without performing a release if the data is ready to transfer. If the device performs a release, the host should reselect the device using the SERVICE command. The device does not perform a release once the data transfer has begun and has been completed.

Write Multiple (C5h)

This command is similar to the Write Sector(s) - 30h command. Interrupts are not presented on each sector, but on the transfer of a block which contains the number of sectors defined by the Set Multiple Mode - C6h command.

Write Multiple Ext (39h)

This command is mandatory for devices that implement the 48-bit Address feature set. The command will write the number of logical sectors specified in the Count field. The command is similar to Write Sector(s) (30h). Interrupts are not presented on each sector, but on the transfer of blocks that contain the number of sectors defined by LBA mode.

Write Multiple FUA Ext (CEh)

This command is mandatory for devices that implement the 48-bit Address feature set. The command has the same functionality of Write Multiple Ext (39h), except that regardless of whether write caching is enabled, the user data is written to the media before the ending status of the command is reported.

Write Sector(s) (30h)

This command will write from 1 to 256 sectors as specified in the Sector Count Register. A sector count of 0 (zero) will request 256 sectors. The transfer begins at the sector specified in the Sector Number Register.

Write Sector(s) Ext (34h)

This command is mandatory for devices that implement the 48-bit Address feature set. The command will write 1 to 65,536 logical sectors as specified in the Sector Count Register. A sector count value of 0 will request 65,536 logical sectors.

SMART Support

SMART is an acronym for Self-Monitoring, Analysis and Reporting Technology. The SMART feature set protects the user from unscheduled downtime by monitoring and storing critical drive performance and calibration parameters. SMART feature set devices attempt to predict the occurrence of near-term degradation or fault conditions. The host system is warned of a negative reliability condition, which in turn warns the user of the impending risk of data loss. The user can then take appropriate action to minimize the risk.

Support for the SMART feature set is indicated by the Identify Command response:

Word 82	Bit 0	The SMART feature set is supported. This information is set during the drive initialization sequence.
Word 85	Bit 0	The SMART feature set has been enabled via the SMART ENABLE OPERATIONS command. The information is dynamic; the SMART ENABLE OPERATIONS command and SMART DISABLE OPERATIONS command are invoked. The most current setting must be reflected in the output of the IDENTIFY DEVICE command. SMART operations are enabled by default.

SMART Commands

Table 9 lists the SMART commands that are identified by the value placed in the Feature register.

Table 9. SMART Command Values

Value	Command	Note
00h-CFh	Reserved	RSVD
D0h	SMART READ DATA	Optional
D1h	Obsolete	OBS
D2h	SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE	Mandatory
D3h	Obsolete	OBS
D4h	SMART EXECUTE OFF-LINE IMMEDIATE	Optional
D5h	SMART READ LOG	Optional
D6h	SMART WRITE LOG	Optional
D7h	Obsolete	OBS
D8h	SMART ENABLE OPERATIONS	Mandatory
D9h	SMART DISABLE OPERATIONS	Mandatory
DAh	SMART RETURN STATUS	Mandatory
DBh	Obsolete	OBS
DCh-DFh	Reserved	RSVD
E0h-FFh	Vendor-Specific	VSC

SMART Attributes

Table 10 lists the SMART attributes that are supported.

Table 10. Supported SMART Attributes

ID	Name	Description
1	Raw Read Error	Frequency of errors while reading raw data from a disk.
9	Power On Hours	Number of hours elapsed in the Power-On state.
12	Power Cycle	Number of Power-On events.
187	Reported Uncorrectable Errors	The number of uncorrectable errors reported at the interface.
194	Temperature	Temperature of base casting.
195	ECC On-the-Fly	Number of ECC on-the-fly errors.
196	Offline Reallocation Event	Total number of sectors remapped.
197	Pending Defects	Number of sectors currently suspected in need of remapping.
198	Offline Surface Scan	Number of uncorrected errors that occurred during offline scan.
199	UDMA CRC Error (PATA Only)	Number of CRC errors during UDMA mode.

Identify Response Information

The Identify Response command enables the host to receive parameter information from the SSD. When the Identify Response command executes, the SSD sets the BSY bit, prepares to transfer the 256 words of SSD identification data to the host, sets the DRQ bit, clears the BSY bit, and then generates an interrupt. The host can then transfer the data by reading the data register. *Reserved bits or words are all zero.* Table 11 contains typical Identify Response Information for the SSD.

Identify Response Information Key	
F	Content of the word is fixed and does not change. For removable media devices, these values may change when the media is removed or changed.
V	Content of the word is variable and may change depending on the state of the device or the commands executed by the device.
X	Content of the word is vendor-specific and may be fixed or variable.
R	Content of the word is reserved and shall be 0 (zero).

Table 11. Identify Response Information

Word	F/V	Description
0		General configuration bit-significant information (value fixed by CFA)
	F	15 0 = ATA Device
	F	41:8 Retired
	F	7:6 Obsolete
	F	5:3 Retired
	V	2 Response Incomplete
	F	1 Retired
	F	0 Reserved
1	V	Obsolete
2	V	Specific Configuration
3	F	Obsolete
4 -5	F	Retired
6	F	Obsolete
7 - 8	V	Reserved for assignment by the CompactFlash™ Association
9	F	Retired
10 - 19	F	Serial Number (20 ASCII Characters)
20 - 21	F	Retired
22	F	Obsolete
23 - 26	F	Firmware Revision (8 ASCII Characters)
27 - 46	F	Model Number (40 ASCII Characters)
47	X	15:8 80h
	R	7:0 00h = Reserved
	F	01h - FFh = Maximum number of sectors that shall be transferred per interrupt on READ/WRITE MULTIPLE Commands
48	F	Trusted Computing Feature Set Options
		15 Shall be cleared to zero
		14 Shall be set to zero
		13:1 Reserved for the Trusted Computing Group
		0 1 = Trusted Computing Feature Set is supported.
49		Capabilities
	R	15:14 Reserved for IDENTIFY PACKET DEVICE Command

	F	13	1 = Standby timer values as specified in this standard are supported 0 = Standby timer values shall be managed by the device
	R	12	Reserved for IDENTIFY PACKET DEVICE Command
	F	11	1 = IORDY supported 0 = IORDY may be supported
	F	10	1 = IORDY may be disabled
	R	9	1 = LBA supported
	R	8	1 = DMA supported
	X	7:0	Retired
50	F	Capabilities	
		15	Shall be cleared to zero
		14	Shall be set to one
		13 :2	Reserved
		1	Obsolete
		0	Shall be set to one to indicate a device-specific Standby Timer Value minimum
51 - 52	F	Obsolete	
53	R	15:8	Reserved for e06144
	F	7:3	Reserved
		2	1 = The fields reported in Word 88 are valid 0 = The fields reported in Word 88 are invalid
	F	1	1 = The fields reported in Words 70:64 are valid 0 = The fields reported in Words 70:64 are invalid
	V	0	Obsolete
54 - 58	X	Obsolete	
59	R	15:9	Reserved
	V	8	1 = Multiple Sector Setting is Valid
		7:0	XXh = Current setting for number of sectors that shall be transferred per interrupt on READ/WRITE MULTIPLE Command
60 - 61	F	Total Number of User-Addressable Sectors (LBA Mode only)	
62	F	Obsolete	
63	R	15:11	Reserved
	V	10	1 = Multiword DMA Mode 2 is selected 0 = Multiword DMA Mode 2 is not selected
	V	9	1 = Multiword DMA Mode 1 is selected

	V	8	0 = Multiword DMA Mode 1 is not selected 1 = Multiword DMA Mode 0 is selected
	R	7:3	0 = Multiword DMA Mode 0 is not selected Reserved
	F	2	1 = Multiword DMA Mode 2 and below are supported
	F	1	1 = Multiword DMA Mode 1 and below are supported
	F	0	1 = Multiword DMA Mode 0 is supported
64	F	15:8	Reserved
	F	7:0	PIO Modes supported
65	F	15:0	Minimum Multiword DMA Transfer Cycle Per Word Cycle Time in Nanoseconds
66	F	15:0	Manufacturer's Recommended Multi-word DMA Transfer Cycle Cycle Time in Nanoseconds
67	F	15:0	Minimum PIO Transfer Cycle Time without Flow Control Cycle Time in Nanoseconds
68	F	15:0	Minimum PIO Transfer Cycle Time with IORDY Flow Control Cycle Time in Nanoseconds
69 - 70	R		Reserved (For Future Command Overlap and Queuing)
71 - 74	R		Reserved for IDENTIFY PACKET DEVICE Command
75	F	15:5	Queue Depth Reserved
		4:0	Maximum Queue Depth - 1
76 - 79	R		Reserved for Serial ATA
80	F		Major Revision Number 0000h or FFFFh = Device does not report version
		15:9	Reserved
		8	1 = Supports ATA8-ACS
		7	1 = Supports ATA/ATAPI-7
		6	1 = Supports ATA/ATAPI-6
		5	1 = Supports ATA/ATAPI-5
		4	1 = Supports ATA/ATAPI-4
		3	Obsolete
		2	Obsolete
		1	Obsolete

		0 Reserved
81	F	Minor Revision Number 0000h or FFFFh = Device does not report version 0001h-FFFFh = Revision of ATA Standard guiding minor version number implementation
82	F	Command Set Supported 15 Obsolete 14 1 = NOP Command supported 13 1 = READ BUFFER Command supported 12 1 = WRITE BUFFER Command supported 11 Obsolete 10 1 = Host Protected Area Feature Set supported 9 1 = DEVICE RESET Command supported 8 1 = SERVICE Interrupt supported 7 1 = RELEASE Interrupt supported 6 1 = Look Ahead supported 5 1 = Write Cache supported 4 Shall be cleared to zero to indicate that the PACKET feature set is not supported 3 1 = Power Management Feature Set supported (mandatory) 2 Obsolete 1 1 = Security Mode Feature Set supported 0 1 = SMART Feature Set supported
83	F	Command Sets Supported 15 Shall be cleared to zero 14 Shall be set to one 13 1 = FLUSH CACHE EXT Command supported 12 1 = FLUSH CACHE Command supported (mandatory) 11 1 = Device Configuration Overlay feature set supported 10 1 = 48-Bit Address feature set supported 9 1 = Automatic Acoustic Management feature set supported 8 1 = SET MAX security extension supported 7 See Address Offset Reserved Area Boot, INCITS TR27:2001 6 1 = SET FEATURES subcommand required to spin-up after power-up 5 1 = Power-Up in Standby feature set supported

		4 Obsolete 3 1 = Advanced Power Management feature set supported 2 1 = CFA feature set supported 1 1 = READ/WRITE DMA QUEUED supported 0 1 = DOWNLOAD MICROCODE Command supported
84	F	Command Set/Feature Supported Extension 15 Shall be cleared to zero 14 Shall be set to one 13 1 = IDLE IMMEDIATE with UNLOAD FEATURE supported 12 Reserved for Technical Report INCITS TR-37-2004 (TLC) 11 Reserved for Technical Report INCITS TR-37-2004 (TLC) 10:9 1 = Obsolete 8 1 = 64-Bit World Wide Name supported 7 1 = WRITE DMA QUEUED FUA EXT Command supported 6 1 = WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands supported 5 General Purpose Logging feature set supported 4 1 = Streaming feature set supported 3 1 = Media Card Pass Through Command feature set supported 2 1 = Media Serial Number supported 1 1 = SMART Self-Test supported 0 1 = SMART Error-Logging supported
85	V	Command Set/Feature Enabled 15 Obsolete 14 1 = NOP Command enabled 13 1 = READ BUFFER Command enabled 12 1 = WRITE BUFFER Command enabled 11 Obsolete 10 1 = Host Protected Area has been established (i.e., the maximum LBA is less than the maximum native LBA) 9 1 = DEVICE RESET Command enabled 8 1 = SERVICE Interrupt enabled 7 1 = RELEASE Interrupt enabled 6 1 = Look Ahead enabled 5 1 = Write Cache enabled

		4 Shall be cleared to zero to indicate that the PACKET feature is not supported. 3 1 = Power Management Feature Set enabled 2 Obsolete 1 1 = Security Mode Feature Set enabled 0 1 = SMART Feature Set enabled
86	V	Command Set/Feature Enabled 15 1 = Words 120:119 are valid 14 Reserved 13 1 = FLUSH CACHE EXT Command supported 12 1 = FLUSH CACHE Command supported 11 1 = Device Configuration Overlay supported 10 1 = 48-Bit Address features set supported 9 1 = Automatic Acoustic Management feature set enabled 8 1 = SET MAX security extension enabled by SET MAX SET PASSWORD 7 Reserved for Address Offset Reserved Area Boot, INCITS TR27:2001 6 1 = SET FEATURES subcommand required to spin-up after power-up 5 1 = Power-Up in Standby feature set enabled 4 Obsolete 3 1 = Advanced Power Management feature set enabled 2 1 = CFA feature set supported 1 1 = READ/WRITE DMA QUEUED Command supported 0 1 = DOWNLOAD MICROCODE Command supported
87	V	Command Set/Feature Enabled 15 Shall be cleared to zero 14 Shall be set to one 13 1 = IDLE IMMEDIATE with UNLOAD FEATURE supported 12 Reserved for Technical Report, INCITS TR-37-2004 (TLC) 11 Reserved for Technical Report, INCITS TR-37-2004 (TLC) 10:9 Obsolete 8 1 = 64-Bit World Wide Name supported 7 1 = WRITE DMA QUEUED FUA EXT Command supported 6 1 = WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands supported

		5	1 = General Purpose Logging feature set supported
		4	1 = Obsolete
		3	1 = Media Card Pass Through Command feature set supported
		2	1 = Media Serial Number is valid
		1	1 = SMART Self-Test supported
		0	1 = SMART Error-Logging supported
88	Ultra DMA Modes		
	F	15	Reserved
	V	14	1 = Ultra DMA Mode 6 is selected 0 = Ultra DMA Mode 6 is not selected
	V	13	1 = Ultra DMA Mode 5 is selected 0 = Ultra DMA Mode 5 is not selected
	V	12	1 = Ultra DMA Mode 4 is selected 0 = Ultra DMA Mode 4 is not selected
	V	11	1 = Ultra DMA Mode 3 is selected 0 = Ultra DMA Mode 3 is not selected
	V	10	1 = Ultra DMA Mode 2 is selected 0 = Ultra DMA Mode 2 is not selected
	V	9	1 = Ultra DMA Mode 1 is selected 0 = Ultra DMA Mode 1 is not selected
	V	8	1 = Ultra DMA Mode 0 is selected 0 = Ultra DMA Mode 0 is not selected
	F	7	Reserved
	F	6	1 = Ultra DMA Mode 6 and below are supported
	F	5	1 = Ultra DMA Mode 5 and below are supported
	F	4	1 = Ultra DMA Mode 4 and below are supported
	F	3	1 = Ultra DMA Mode 3 and below are supported
	F	2	1 = Ultra DMA Mode 2 and below are supported
	F	1	1 = Ultra DMA Mode 1 and below are supported
	F	0	1 = Ultra DMA Mode 0 is supported
89	F	Time required for Security Erase Unit completion	
90	F	Time required for Enhanced Security Erase completion	
91	V	Current Advanced Power Management value	
92	V	Master Password Identifier	

93			Hardware Reset Result. The contents of bits (12:0) of this word shall change only during the execution of a hardware reset. See 7.16.7.41 for more information.
	F	15	Shall be cleared to zero.
	F	14	Shall be set to one.
		13	1 = Device detected CBLID - above V_{IH} 0 = Device detected CBLID - below V_{IL}
		12:8	Device 1 Hardware Reset Result. Device 0 shall clear these bits to zero. Device 1 shall set these bits as follows:
	F	12	Reserved
			11 0 = Device 1 did not assert PDIAG- 1 = Device 1 asserted PDIAG-
		10:9	These bits indicate how Device 1 determined the device number. 00 = Reserved 01 = A jumper was used. 10 = The CSEL signal was used. 11 = Some other method was used/method unknown
		8	Shall be set to one.
		7:0	Device 0 Hardware Reset Result. Device 1 shall clear these bits to zero. Device 0 shall set these bits as follows:
	F	7	Reserved
	F	6	0 = Device 0 does not respond when Device 1 is selected. 1 = Device 0 responds when Device 1 is selected.
	V	5	0 = Device 0 did not detect the assertion of DASP-. 1 = Device 0 detected the assertion of DASP-.
	V	4	0 = Device 0 did not detect the assertion of PDIAG-. 1 = Device 0 did detect the assertion of PDIAG-.
	V	3	0 = Device 0 failed diagnostics. 1 = Device 0 passed diagnostics.
		2:1	These bits indicate how Device 0 determined the device number. 00 = Reserved 01 = A jumper was used. 10 = The CSEL signal was used. 11 = Some other method was used/method unknown
	F	0	Shall be set to one.

94	F	15:8 7:0	Vendor's recommended acoustic management value. Current automatic acoustic management value.
95	F		Stream Minimum request size
96	V		Streaming Transfer Time - DMA
97	V		Streaming Access Latency - DMA and PIO
98-99	F		Streaming Performance Granularity
100-103	V		Total Number of User-Addressable Sectors for 48-bit Address feature set.
104	V		Streaming Transfer Time - PIO
105	F		Reserved
106	F		Physical Sector Size/Logical Sector Size
	F	15	Shall be cleared to zero.
	F	14	Shall be set to one.
	F	13	1 = Device has multiple logical sectors per physical sector
		12	1 = Device Logical Sector is greater than 256 words.
		11:4	Reserved
		3:0	2 ^x logical sectors per physical sector
107	F		Inter-seek delay for ISO-7779 acoustic testing in microseconds
108	F	15:12 11:0	NAA (3:0) IEEE OUI (23:12)
109	F	15:4 3:0	IEE OUI (11:0) Unique ID (35:32)
110	F	15:0	Unique ID (31:16)
111	F	15:0	Unique ID (15:0)
112-115	F		Reserved for World Wide Name Extension to 128 bits
116	V		Reserved for INCITS TR-37-2004
117-118	F		Words per Logical Sector
119			Supported Settings (Continued from Words 84:82)
	F	15	Shall be cleared to zero.
	F	14	Shall be set to one
	F	13:6	Reserved
		5	Reserved for e06144
	F	4	1 = The Segmented feature for DOWNLOAD MICROCODE is supported.

	F	3	1 = READ and WRITE DMA EXT GPL optional commands are supported.
	F	2	1 = WRITE UNCORRECTABLE is supported
	F	1	1 = Write-Read-Verify feature set is supported.
	F	0	Reserved for DT1825
120		Command Set/Feature Enabled/Supported (Continued from Words 87:85)	
	F	15	Shall be cleared to zero
	F	14	Shall be set to one
	F	13:6	Reserved
		5	Reserved for e06144
	F	4	1 = The Segmented feature for DOWNLOAD MICROCODE is supported.
	F	3	1 = READ and WRITE DMA EXT GPL optional commands are supported.
	F	2	1 = WRITE UNCORRECTABLE is supported
	F	1	1 = Write-Read-Verify feature set is enabled
	F	0	Reserved for DT 1825
121-126	F	Reserved for Expanded Supported and Enabled Settings	
127		Obsolete	
128	V	Security Status	
		15: 9	Reserved
		8	Security Level: 0 = High, 1 = Maximum
		7: 6	Reserved
		5	1 = Enhanced Security Erase supported
		4	1 = Security Count Expired
		3	1 = Security Frozen
		2	1 = Security Locked
		1	1 = Security Enabled
		0	1 = Security Supported
129 - 159	X	Vendor Specific	
160	V	CFA Power Mode 1	
		15	Word 160 supported
		14	Reserved
		13	CFA Power Mode 1 is required for one or more commands implemented by the device

		12	CFA Power Mode 1 disabled
		11:0	Maximum Current in mA
161 - 175	R	Reserved for assignment by the CompactFlash™ Association	
176 - 205	V	Current Media Serial Number (60 ASCII Characters)	
206		SCT Command Transport	
		15:12	Vendor Specific
		11:6	Reserved
	F	5	SCT Command Transport Data Tables supported
	F	4	SCT Command Transport Features Control supported
	F	3	SCT Command Transport Error Recovery Control supported
	F	2	SCT Command Transport Write Same supported
	F	1	SCT Command Transport Long Sector Access supported
	F	0	SCT Command Transport supported
207 - 208	F	Reserved for CE-ATA	
209	F	Alignment of Logical Blocks within a Larger Physical Block	
		15	Shall be cleared to zero
		14	Shall be set to one
		13:0	“Logical Sector” offset within the first physical sector where the first logical sector is placed.
210 - 211	V	Write-Read-Verify Sector Count Mode 3 Only	
212 - 213	F	Verify Sector Count Mode 2 Only	
214		NV Cache Capabilities	
	F	15:12	NV Cache feature set version
	F	11:8	NC Cache Power Mode feature set version
		7:5	Reserved
		4	1 = NV Cache feature set enabled
		3:1	Reserved
		0	1 = NV Cache Power Mode feature set enabled
215	V	NV Cache Size in Logical Blocks (LSW)	
216	V	NV Cache Size in Logical Blocks (MSW)	
217	V	NV Cache Read Transfer Speed in MB/s	
218	V	NV Cache Write Transfer Speed in MB/s	
219		NV Cache Options	
		15:8	Reserved
	F	7:0	Device Estimated Time to Spin Up in Seconds

220	V	15:8 Reserved 7:0 Write-Read-Verify feature set current mode
221		Reserved
222	F	Transport Major Revision Number. 0000h or FFFFh = Device does not report version. 15:12 Transport Type - 0 = Parallel, 1 = Serial, 2-15 = Reserved Parallel 11:4 Reserved 3 Reserved 2 Reserved 1 Reserved 0 ATA8-APT Serial 11:4 Reserved 3 SATA Rev 2.5 2 SATA II: Extensions 1 SATA 1.0a 0 ATA8-AST
223	F	Transport Minor Revision Number
224 - 233	F	Reserved for CE-ATA
234	F	Minimum number of 512 byte units per DOWNLOAD MICROCODE command Mode 3
235	F	Maximum number of 512 byte units per DOWNLOAD MICROCODE command Mode 3
236 - 254		Reserved
255	X	Integrity Word 15:8 Checksum 7:0 Signature

Vendor-Specific ATA Commands

As with standard ATA commands, the software requirements and syntax of the vendor-specific ATA commands the host issues to the Zeus SSD are issued to the ATA by loading the required registers in the command block with supplied parameters, and then writing the command code to the register. For additional information on proprietary STEC ATA commands, contact your STEC representative. The contact information is found under [Contact and Ordering Information](#).

Sanitize Erase/Fill

Zeus SSDs offer optional destructive and non-destructive sanitization (purge) features. Non-destructive security erase removes the data from the drive, then overwrites (fills) each addressable block of memory with a predetermined pattern, as specified by the sanitization specification, such as DoD 5220.22M, to which the SSD complies.

The destructive security erase feature removes the data, and then destroys the flash media, making the SSD totally unusable and data retrieval impossible. The non-destructive and destructive security erase algorithms monitor and confirm completion of the sanitization process.

In the event of a power loss, the status of the executing purge is maintained and the purge process is restarted on the next power-up automatically.

While a purge command is being executed, the interface is ignored and any attempt to reset the drive (hard or soft) will fail.

Both security erase features support Low Power and Fast Erase options. The Low Power option accesses each addressable memory block sequentially to conserve power. The Fast Erase option accesses all addressable blocks simultaneously, forgoing power conservation for speed.

Sanitization Standards

Zeus SATA SSDs comply with the sanitization requirements described in *Table 12*.

Table 12. Sanitize Standards Compliance

Specification	Document Description/Comment
USA DoD 5220.22-M	National Industrial Security Program, Operation Manual (NISOM), January 1995. Specifies the sanitization process for various media types in order to be considered declassified.
NSA 130-2	Media Declassification and Destruction Manual, November 2000. Specifies the sanitization procedure for semiconductor memory devices.
AR 380-19	Information Systems Security (ISS), March 27, 1998. Provides the security requirements for systems processing Special Access Program (SAP) information and describes the ISS policy as it applies to security in hardware, software procedures, telecommunication, personal use, physical environment, networks and firmware. Section VII, Automated Information System Media, Section 2-20, describes cleaning, purging, declassifying and destroying media. Appendix F-2 describes how to sanitize flash memory.
AFSSI 5020	USA Air Force System Security, Instruction (AFSSI) 5020, 10, August 1996. Specifies the sanitization procedure for confidential media. Chapter 5, Semiconductor Devices, describes the security procedure for all types of semiconductor media. Paragraph 5.3 describes the procedure for sanitizing flash memory.
Navso P-5239-26	Information Systems Security (INFOSEC) Program Guidelines. Provides policy, guidelines, and procedures for clearing and purging computer system memory and other storage media for release outside of and for reuse within controlled environments. It pertains to both classified and sensitive unclassified information. Implements DOD 5200.28-M and CSC-STD-005-85. Chapter 3 describes the cleaning and purging of data storage media.

PHYSICAL CHARACTERISTICS

General Physical Characteristics

Materials

All acceptable enclosure materials are HB rated or higher if approved by the safety agencies (UL, CSA, TUV, etc.). All printed circuit boards shall have a flammability rating of UL94V-0.

Drive Assembly Weight

The weight of a SSD varies according to the specific set of design characteristics of the drive. A standard 2.5-inch SSD with a capacity of 16GB weighs less than 100 grams. The following characteristics must be taken into consideration to determine the exact weight of a drive:

- Storage capacity
- IC stacking technology (if used)
- Flash controller/memory configuration
- Form factor

Storage Capacities

Table 13 lists of the available capacities of the Zeus SATA SSDs and the corresponding LBA (Logical Bit Addressing) and CHS (Cylinder, Head, Sector) information. The *CHS Capacity* is expressed as *User-Addressable LBA Sectors*. The extended use of the device shall not reduce the LBA count. The LBA count will remain constant over the life of the SSD.

Table 13. Zeus SSD Capacities

Capacity (GB) (Unformatted)	Logical Bit Addressing (LBA Data)	Cylinder, Head, Sector (CHS) Data			
	User-Addressable LBA Sectors	CHS Capacity	Logical Cylinders	Logical Heads	Logical Sectors
8	16,090,112	16,089,696	15,962	16	63
12	24,208,176	16,514,064	16,383	16	63
16	32,196,608	16,514,064	16,383	16	63
24	48,302,080	16,514,064	16,383	16	63
32	64,408,576	16,514,064	16,383	16	63
48	97,018,016	16,514,064	16,383	16	63
64	121,717,680	16,514,064	16,383	16	63
96	182,378,848	16,514,064	16,383	16	63
128	243,435,360	16,514,064	16,383	16	63

Exterior Dimensions

The internal components are housed in precision machined aluminum alloy enclosures. *Table 14* lists the exterior dimensions of the 2.5-inch form factor drive. The 2.5-inch drive assembly and overall dimensions are illustrated in *Figure 4*.

Table 14. 2.5 Drive Assembly Dimensions

Dimension	Inches (Millimeters)
Height	0.374 inches (9.5mm)
Width	2.76 inches (69.8mm)
Length (Maximum)	3.94 inches (100.2mm)

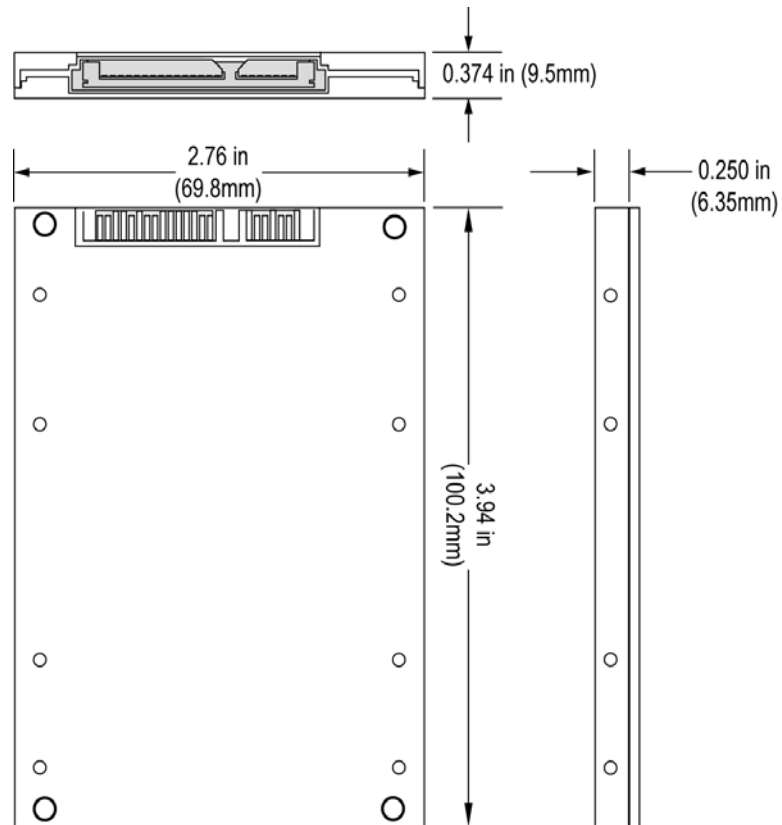


Figure 4. Zeus 2.5-inch SSD Assembly Dimensions

SATA Connector Location

Figure 5 illustrates the relative location of the SATA connector on the SSD.

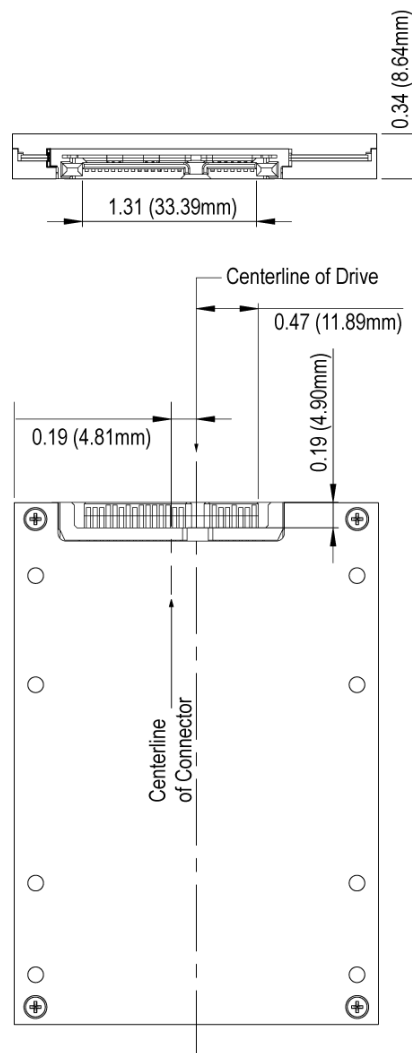


Figure 5. SATA Connector Location

ENVIRONMENTAL CHARACTERISTICS

Overview

The SSDs are subjected to a series of environmental tests to validate the portability and suitability of the drives for operation in harsh and mobile conditions. The SSDs operate without degradation within the ambient temperature, relative humidity and altitude ranges as specified in the following sections.

Operating Temperatures

The SSDs (all models) operate without degradation within the ambient temperature ranges specified in *Table 15*.

Table 15. *Operating Temperatures*

Operating Temperature	Centigrade (°C)		Fahrenheit (°F)	
	Minimum	Maximum	Minimum	Maximum
Commercial	0	70	32	158
Industrial	-40	85	-40	185

Operating Requirements

Note: For the operating requirements, the ambient air temperature is that of the inlet air for the equipment. See *Table 16*.

Table 16. *Non-Operating Conditions*

Operating Requirement	
Case Temperature	-55°C to 95°C
Maximum Temperature Gradient	30°C/h
Short Duration Temperature	82°C for 2h
Relative Humidity (Non-condensing)	10% to 90%
Maximum Wet Bulb Temperature	20°C

Non-Operating Requirements

Note: Non-operating requirements include shipment and storage environments. See *Table 17*.

Table 17. *Non-Operating Conditions*

Non-Operating Requirement	
Temperature Range	-55°C to 95°C
Maximum Temperature Gradient	30°C/h
Short Duration Temperature	82°C for 2h
Relative Humidity (Non-condensing)	5% to 95%
Maximum Wet Bulb Temperature	38°C
Maximum Relative Humidity Gradient	20%/h

Relative Humidity

Table 18 lists the operating and non-operating relative humidity criteria for the SSD.

Table 18. *Relative Humidity Operating Criteria*

Operating	Criteria
Relative Humidity Range (Non-Condensing)	5% to 95%
Maximum Wet Bulb Temperature	29°C
Maximum Relative Humidity Gradient	20%/h
Non-Operating	Criteria
Relative Humidity Range (Non-Condensing)	5% to 95%
Maximum Wet Bulb Temperature	38°C
Maximum Relative Humidity Gradient	20%/h

Altitude Parameters

Operating and non-operating altitude parameters for the Zeus SSD are the same. See *Table 19* for the altitude limits. Altitude is referenced to sea level on a standard day at 19.8°C (58.64°F).

Table 19. *Operating and Non-Operating Altitudes*

Altitude Parameter	Range
Low Altitude Limit	-304.80m (-1,000 ft.)
High Altitude Limit	24,384m (80,000 ft.)

Restriction of Hazardous Materials

STEC Inc. has adopted the RoHS Directive, also known as the Restriction of Hazardous Substances Directive. Zeus SSDs are compliant with the European Parliament and Council Directive, i.e., assembled with Pb-free or lead-free components.

Shock and Vibration

This section specifies the capability of the device to withstand shock and vibration. Shock and vibration are specified on the drive chassis. Resonance may occur if the drive is placed in an enclosure. It is the responsibility of the user to design the mounting such that the drive movement is within the specified ranges despite resonance.

Failure Criteria

Test failures are defined as:

- Any single hard error (unrecoverable error)
- Damage that renders a product inoperable
- Failure meet performance specifications

Random Vibration

For random vibration, the drives will perform without any errors after being tested at 15 min/axis on three axes (X, Y and Z). During the operational vibration, the drive will be performing continuous reads. The SSD also adheres to 16.3G RMS per MIL-STD-810F (Random, 20 Hz to 2,000 Hz; 3 vibration axes). Vibration levels are listed in *Table 20*. In addition to the previously mentioned Failure Criteria, during the operating random vibration, the transfer rate of the drive should not degrade by more than 10%.

Table 20. Random Vibration Levels

Parameter	Value	Condition
Operating Vibration	16.3	G, RMS, 20Hz, 1 Hour Duration, 3 Axes

Shock

The SSD is shock-tested in accordance with MIL-STD-810F and will operate as specified, without degradation, when subjected to the following conditions outlined in *Table 21*.

Table 21. Shock Test Results

Test Condition	Result
Three 50G Shocks (Peak Value, 11ms duration, half-sine waveform) along the X, Y and Z axis.	1,500G Operating Shock

Drop Testing

The SSD will withstand three (3) drops on a concrete floor from 1.524m (60 inches) on each of six (6) axes, +/-X, +/-Y, and +/-Z, without any damage when packaged.

Conformal Coating

As an option, the user can choose to have the factory apply a conformal coating to the electronic circuitry of the Zeus SSD to further protect against moisture, dust, chemicals and temperature extremes. The material coating may actually reduce the effects of mechanical stress and vibration on the circuitry.

The coating material should achieve an approximate thickness of between 50 and 100 micrometers after curing. A thicker coating may be required when liquid water is present due to microscopic pinhole formation when the coating material thins on the sharp edges of components. Enough material is applied to completely cover the components to a depth equal to or greater than the highest metallic conductor on the PCB.

The conformal coating physical characteristics meet IPC-CC-830 regulations for the qualification and performance of electrical insulating compounds for printed wiring assemblies. The workmanship standard is in accordance with IPC-A610, Section 10.5.2.

The HumiSeal 1B31 Acrylic or equivalent coating is applied to both sides of the PCB, and masks the connector body and pins of the connectors, and some component topsides.

INSTALLATION

System Requirements



There is a risk of electrocution! Use extreme caution when handling the solid state drive and while connecting it to a power source. Observe all applicable electrical safety rules while installing the solid state drive. Make sure to read and thoroughly understand this section before attempting to install the drive.

SATA Connections

The SSDs can be installed in any operating system environment that supports SATA 1.0 or greater devices (the SSDs are compliant to SATA 2 standards). If the system fails to recognize the drive, make sure the most recent drivers for the host adapter are installed. If the drive is connected to the motherboard, the drivers are provided by the motherboard manufacturer. If the drive is connected to a PCI card, contact the PCI card manufacturer. Changes to the operating system are not required: The SSDs support all ATA and ATAPI devices, including CDs, DVDs, tape devices, high-capacity removable devices, Zip drives, and CDRWs.

Make sure you have the following before installing the Zeus SATA SSD:

- Phillips screwdriver
- Six M3 UNC machine screws
- SATA interface cable (1 meter (39 inches) maximum length)
- SATA-compatible power cable or adapter
- Operating system
- Computer with Serial ATA connector on motherboard or installed SATA host adapter
- Available 5V power source

Drive Configuration

Serial ATA drives do not support Primary/Secondary device negotiation. Each SATA drive requires a separate cable that connects directly to a SATA host adapter or SATA port on the motherboard of the host. Since most motherboards with Serial ATA connectors do not allow BIOS adjustments, changes are not typically required to add a SATA drive. However, if replacing the boot drive, it may be necessary to change the boot order in the BIOS so that the computer boots from the Serial ATA controller.

The SSD operates as a single configuration mode (Primary/Device 0 Mode) device. SATA drives can be used in the same system with PATA drives provided that both interfaces are supported on the motherboard or with a host adapter. This makes it easy to add SATA compatibility to an existing system without having to remove any existing PATA disk drives.

Connector Requirements

Table 22 lists the recommended connectors that should be used with the Zeus SSD. The drive side connector is manufactured by Molex, part number 87679-0003. For the host receptacle, the Molex 87678-0001 or equivalent (Serial ATA receptacle, vertical single-in-line through hole backplane) is recommended.

Table 22. Recommended FPC Mating Specifications

Drive Side Connector	
Manufacturer	Molex
Part Number	87679-0003
Mating FPC	Recommended Specifications
Width	20.50mm +/-0.7mm (0.807 in +/-0.02)
Thickness	0.3mm +/-0.5mm (0.01 in +/-0.001)
Length	90mm max (3.54 in max)
Impedance	50 Ohm Typical
Plating	Gold over Nickel
Adhesive	Heat Hardened
Durability	50 cycles, internal cabled applications 500 cycles, backplane/blindmate applications
Operating Temperature	-40°C to +85°C

Drive Orientation

The SSD can be installed in any number of orientations within the enclosure. The drive will operate and meet all the requirements as outlined in this specification regardless of the mounting orientation. See *Figure 6*.

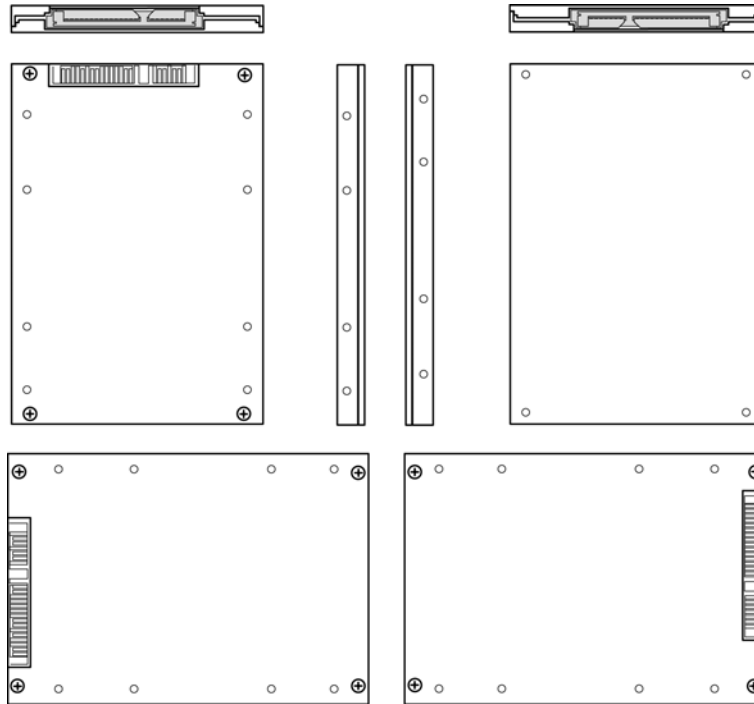


Figure 6. Possible Drive Orientations

Primary Heat Generation Area

Figure 7 indicates the approximate location of the primary heat generation area on the underside of the SSD. See [Cooling Requirements](#).



Exercise caution when handling the drive after extended operation. The heat generated by the internal circuitry can be substantial.

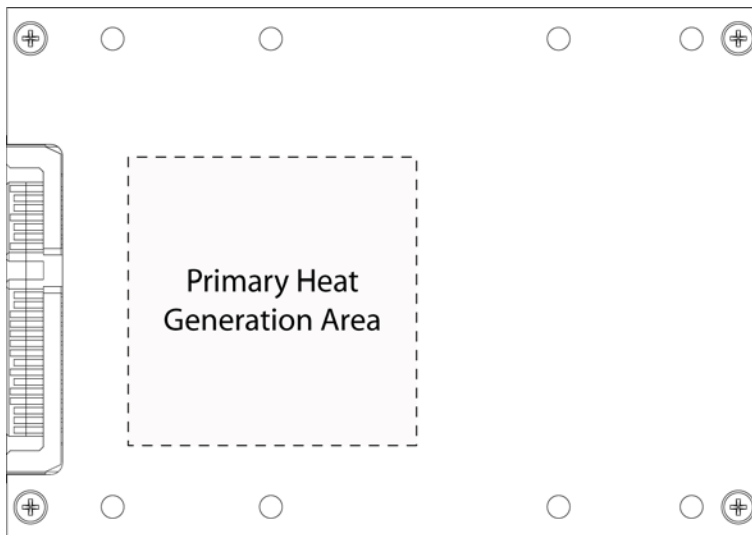


Figure 7. Primary Heat Generation Area

Cooling Requirements

If necessary to maintain the required operating temperature range, the host enclosure may remove heat by conduction, convection, or other forced air flow. Four suggested air flow patterns are shown in *Figure 8*.

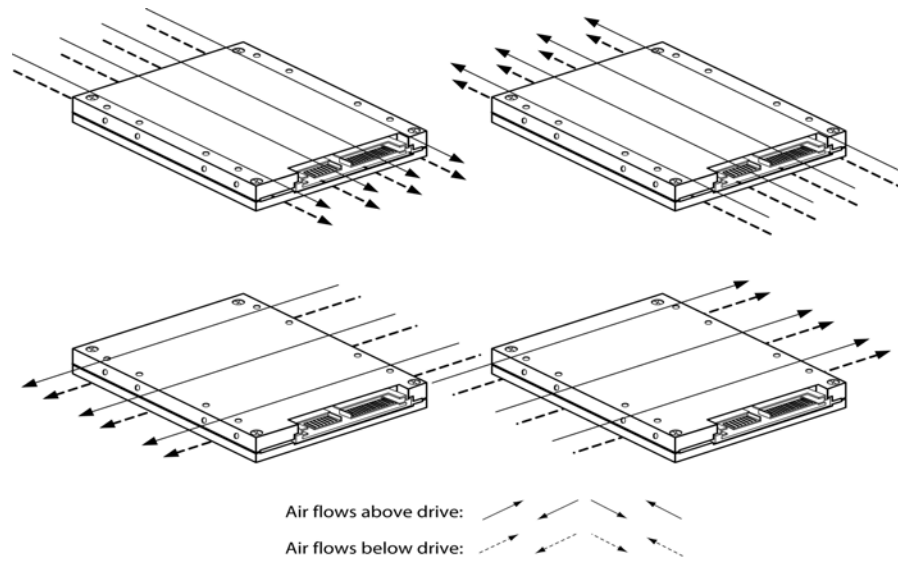


Figure 8. Suggested Air Flow Patterns for Cooling

Installation Dimensions

Figure 9 shows the exterior dimensions of the 2.5-inch form factor with the relative locations of the mounting holes. The units are in inches (millimeters).

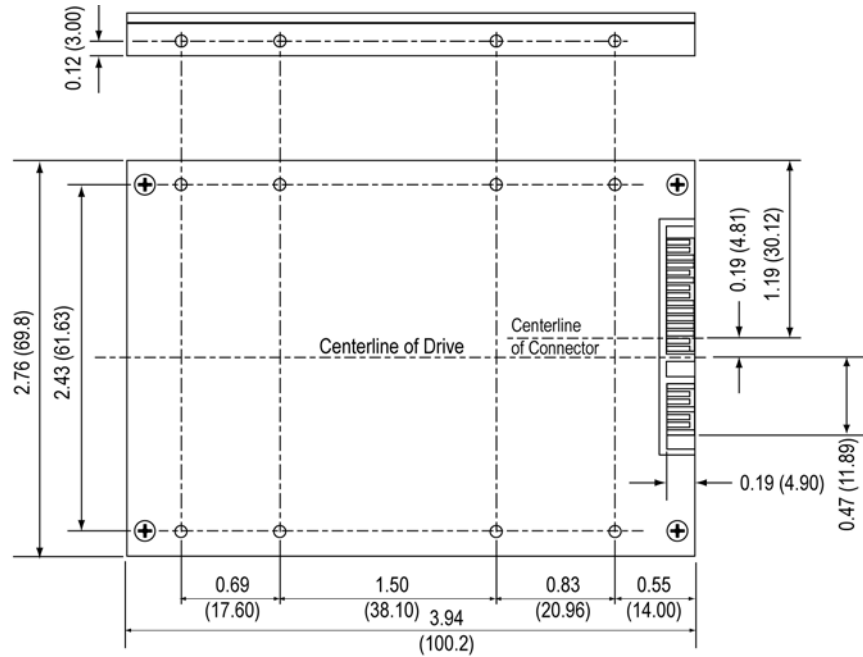


Figure 9. Exterior Mounting Dimensions

Mounting Requirements

Figure 10 shows the mounting hole requirements for the 2.5-inch form factor SSD. Careful attention should be made to the length of the mounting screws and the recommended torque to prevent damage to the enclosure.

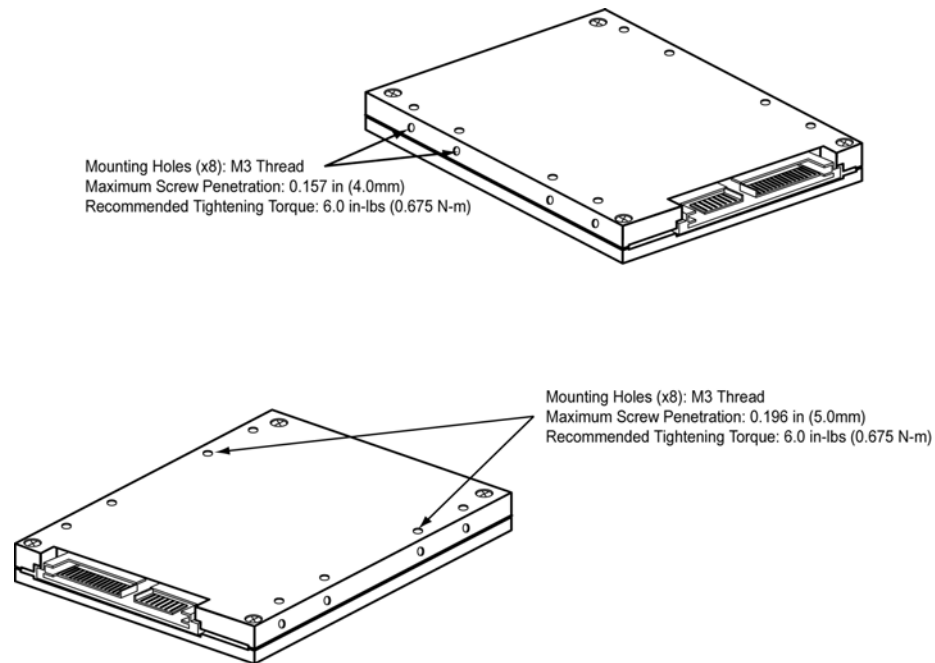


Figure 10. Mounting Hole Requirements

Drive Installation



Electrostatic Discharge or ESD can seriously damage the electronic components of the host system and solid state drive. It is very important to discharge any static electricity before you begin the installation procedure. You can touch an unpainted, grounded metallic surface to discharge any static charges that may be present on your body or clothing. As an alternative, you can also use an ESD protective wrist strap. You can minimize the possibility of damage due to ESD by avoiding physical contact with the electronic components.

To install the Zeus SATA SSD in a personal computer (PC) or host system:

- 1 Power down the computer and remove the access cover.
- 2 Position the SSD in an available drive bay or choose a suitable mounting location.
- 3 Connect one end of an SATA cable to the SSD and the other end of the cable to the SATA adapter on the host. *The connector on the drive is keyed to ensure that the signal and power connections to the drive are correctly oriented.*
- 4 Secure the SSD within the drive bay or to the mounting surface using M3 UNC machine screws. Apply sufficient torque to ensure that the drive is secure.

Note: Be aware of the depth of the drive's mounting holes. The maximum penetration depth of the drive's mounting holes is indicated in *Figure 10*. You may mount the drive using the side or top mounting holes. It is recommended that you secure the drive with at least four screws. To avoid damaging the drive, consider the thickness of the mounting surface when deciding the screw length to use.

- 5 Replace the access cover and power on the computer.

Grounding Requirements

No special grounding circuitry is required. Pins S1, S4 and S7, serve as Ground signals on the Signal Segment, and Pins P4, P5, P6, P10 and P12 serve as Ground signals on the Power Segment of the SATA connector configuration. The signal and chassis grounds are not connected together in the drive. The user should provide maximum surface contact area when connecting the drive to the chassis ground to ensure minimal electromagnetic (EM) emissions.

Operating System Specifications

The SSDs are compatible with Microsoft Windows® and alternative operating systems. The SSDs are low-level formatted at the factory. However, the SSDs must be partitioned and high-level formatted. The SSDs can be formatted as boot drives or data storage drives using any standard disk partitioning and formatting utility.

Microsoft OS Compatibility

The SSDs are fully compatible with the following Microsoft operating systems, using the native drivers supplied with the OS:

- Windows 2000, Service Packs 2, 3 and 4
- Windows 2000 Server, Advanced Server
- Windows XP Home and Windows XP Professional, Service Packs 1 and 2
- Windows XP, 64-Bit Extended
- Windows 2003 Standard, Enterprise, 64-bit, Web, Datacenter, Small Business Server
- MS-DOS
- Windows Pre-boot Environment (WinPE)

The drives are compatible with the current version of the MS-DOS real-mode drivers bundled with any of the Microsoft operating systems for reading files from optical media.

Alternative Operating Systems

The drives are fully compatible with the following operating systems, using the native drivers supplied with the OS:

- Red Hat Linux 2.1
- Red Hat Linux 3.0
- DRMK (Dell Real-Mode Kernel) DOS

System POST, Boot and Resume Times

The drive's effect on the time required for the system to POST, boot and resume under Microsoft Windows XP is minimized. Device implementation will target minimum impact to such. The drives also comply with the Microsoft Fast Boot/Fast Resume Requirement, which is ≤ 2.5 s for Resume from Standby (S3), ≤ 20 s for Resume from Hibernation (S4).

NAND Flash Support

The device will support multiple mutually agreed upon and approved NAND flash memory vendors prior to release to manufacturing for proposed capacities in the design without changes to the hardware or firmware. STEC develops firmware to support a wide range of NAND flash versions and vendors. Please contact STEC for a list of supported flash and flash vendors.

Diagnostic Software

The computer or system manufacturer is responsible for providing any diagnostic software or utilities.

REGULATORY COMPLIANCE

Marking, Approvals and Supporting Documentation

The SSD may have the following marks, approvals and documentation as outlined in *Table 23*.

Table 23. *Regulatory Marks and Documentation*

Mark/Approval	Documentation	Mark
UL	Electrical Equipment sold in the United States of America shall comply with the requirements of UL 1950 or other applicable UL standard and be marked (UL or other NRTL marking) accordingly. STEC will provide the Declaration of Conformity (DoC). UL Notice of Acceptance letter (with corresponding file number) indicating compliance with UL 60950-1.	Yes
CE	Electrical equipment sold in the European Economic Area (EEA) will comply with the requirements of CAN/CSA-C22.2 No. 60950-1-03 and have the CE mark accordingly.	Yes
CSA (or ULc)	Electrical equipment sold in Canada will comply with the requirements of CAN/CSA-C22.2 No. 959-M98 or other applicable Canadian Standards Association standard and be marked (CSA, cUL) accordingly.	Yes
EU	In the European Community (European Union or EU), Information Technology Equipment (ITE) is governed within the EC (EU) by Directive 73/23/ECC ("Low Voltage Directive") for Product Safety and 89/336/EEC - Harmonized standards ("EMC Directive") EN55022, 1998 and EN55024, 1998 for Emissions and Immunity, and all applicable amendments. EC (EU) members are bound by its requirements. Equipment may demonstrate compliance with the directive by being approved to a recognized standard by an EC (EU) recognized agency such as TUV or VDE and a signed Declaration of Conformity, plus the CE mark on the device.	Yes
TUV/SEMKO/UL/etc.	Germany, being part of the EC, is bound by the Low Voltage and EMC Directive. In addition, Germany's Equipment Safety Law requires that equipment will be "... in accordance with the generally recognized rules of technology and the work safety and accident prevention regulations..." Equipment may demonstrate compliance with the directive by being approved to a recognized standard by an EC (EU) recognized agency such as TUV or VDE. STEC will provide CB Certificate and Test Report with the supporting Type Certificate (e.g., TUV Certificate, from the Agency that approved the CB Test Report)	No
MIC (Korea)	Certificate (with certification number)	Yes
BSMI (Taiwan)	Certificate (with corresponding applicant code number)	Yes
VCCI (Japan)	Certificate or Declaration of Conformity. Self declaration that the product has been evaluated in a VCCI compliant lab is sufficient.	Yes
C-TICK (Australia)	Declaration of Conformity (DoC) (with supplier code number) and a Letter of Authorization from supplier giving Dell permission to import and sell the product in Australia using STEC's C-TICK.	No
FCC	Declaration of Conformity	Yes

CB Certificate and CB Report

STEC Inc. will provide a complete CB Report. These documents will include the current and voltage ratings, and prove compliance with the currently applicable versions of IEC 60950-1:2001, Safety of Information Technology Equipment, including all national deviations.

STEC Inc. will also provide the EMC test report indicating compliance with the currently applicable versions of:

- EN-55022:1998 (Emissions)
- EN-55024:1998 (Immunity)
- FCC 47CFR Part 15 Class B

Declaration of Conformity

The Declaration of Conformity (DoC) will contain the following:

- Product type and model number
- Marks and countries (e.g. CE, FCC, C-Tick)
- The appropriate technical statement(s) required by the respective regulatory agencies
- STEC name and address
- STEC signature
- List of all applicable standards to which the drive conforms

Radio Frequency Emissions

The SSD has passed radiated emissions testing (10 meter chamber) with a minimum margin of 4dB below the EN55022 radiated emissions limits in all applicable customer platforms, without any required changes to the system platforms.

Emissions testing in a 3 meter chamber for over 1GHz per the FCC limit for Class B was performed up to 2GHz with the -4dB margin relative to the FCC Class B limit.

In preparation for the new CISPR 22 standard change that may go into effect in the year 2007, the drives will pass EMI tests up to the higher frequency of either 6GHz or the fifth harmonic of the highest signal on the drive. This requirement is applicable to all products being qualified after this version is released. The specification limits are listed in *Table 24*.

Table 24. EMI Specification Limits

Class B	1 to 3 GHz is 50dB (uV/m) @ 3 m
Class B	3 to 6 GHz is 54dB (uV/m) @ 3 m

Radio Frequency Immunity Requirements

This specification is targeted as part of the design for quality and reliability expectations and is not part of the regulatory requirements. The SSDs meet the following radio frequency immunity requirements:

- 3 V/m over frequency range of 80 MHz to 1 GHz
- The signal will be amplitude modulated with a 1KHz sine wave to a depth of 80%
- Failure criteria: More than 10% throughput degradation

EMI Test Site Correlation

STEC will only use EMI test sites that are currently correlated with the customer's test facilities. STEC will contact the customer's engineering staff for the list of approved laboratories.

Verification Samples

STEC will submit the three worst-case drives used to obtain the emissions test data previously obtained from the customer's test facilities for verification testing. The Regulator Engineer will use these drive samples, and others among those submitted for qualification, for emissions verification in the customer's systems.

Verification Testing

Verification testing will be performed by the customer's Compliance Peripheral Group.

Electrostatic Discharge (ESD)

The SSD will meet the ESD limits specified in the 61000-4-2 guidelines and the customer's enhanced ESD procedure. The specification will determine whether the contact or air discharge method should be used. Performance degradation is defined as a decreased throughput rate. No data errors are allowed. *Table 25* lists the ESD requirements.

Table 25. ESD Requirements

Climatic Conditions		
Ambient Temperature	15°C to 35°C	
Relative Humidity	30% to 60%	
Atmospheric Pressure	86kPa (860 millibar) to 106 kPa (1,060 millibar)	
Voltage Level	Discharge Type	Pass/Fail Performance Criteria
+/-2 kV	Contact	A
+/-4 kV	Contact	B
+/- 6 kV	Contact	B
+/-8 kV	Contact	C
+/-2 kV	Air	A
+/-4 kV	Air	A
+/-8 kV	Air	B
+/-12 kV	Air	B
+/-15 kV	Air	C

Acceptance Criteria Definitions

The following table lists the acceptance criteria definitions for the ESD limits.

Table 26. Acceptance Criteria Definitions

A	The apparatus will continue to operate as intended, i.e., normal unit operation with no degradation of performance.
B	The apparatus will continue to operate as intended after completion of the test. However, during the test, some degradation of performance is allowed provided there is no data loss or operator intervention to restore apparatus function.
C	Temporary loss of function is allowed. Operator intervention is acceptable to restore apparatus function.
	Note: Hardware failures are not acceptable for any level of the above performance criteria.

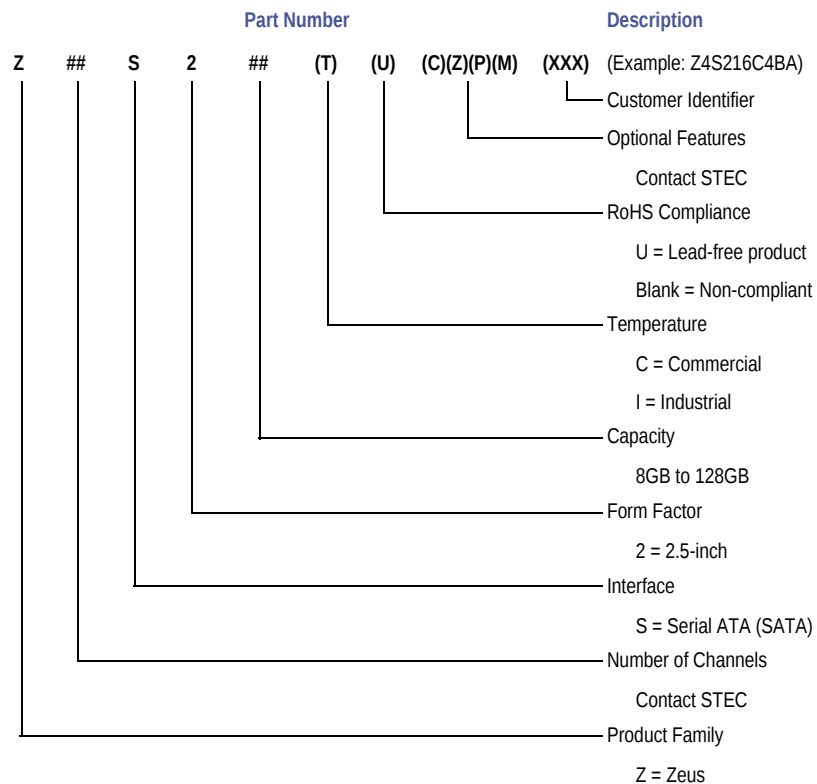
CONTACT AND ORDERING INFORMATION

Contact Information

For more information on Zeus Solid State Drives, contact the Solid State Drive Team.

Telephone:	800-796-4645 (Toll free; US and Canada only)
All Others:	+1-949-260-8345
Fax:	+1-949-417-1335
E-mail:	ssd@stec-inc.com

Ordering Information



ACRONYMS AND ABBREVIATIONS

A

ARM (Advanced RISC Machine) <processor> (ARM, Originally Acorn RISC Machine). A series of low-cost, power-efficient 32-bit RISC microprocessors for embedded control, computing, digital signal processing, games, consumer multimedia and portable applications.

ATA (AT Attachment) The IDE interface is officially known as the ATA specification. ATA-2 (Fast ATA) defined the faster transfer rates used in Enhanced IDE (EIDE). ATA-3 added interface improvements, including the ability to report potential problems (see S.M.A.R.T.). Starting with ATA-4, either the word “Ultra” or the transfer rate was added to the name in various combinations. For example, at 33 MBytes/sec, terms such as Ultra ATA and ATA-33 have been used. In addition, Ultra ATA-33, DMA-33 and Ultra DMA-33 are also found.

C

CFA (Computer Fraud and Abuse Act of 1986) The CFA was a significant step forward in criminalizing unauthorized access to computer systems and networks. The Act applies to “federal interest computers” which include systems used by the U.S. government, as well as most financial institutions. The Act makes unauthorized penetration or other damage to such systems a felony.

CHS Cylinder, Head, Sector. A disk-drive system and method for generating logical zones that each have an approximate number of spare sectors, and that are used to translate logical block addresses.

CISC (Complex Instruction Set Computer) Pronounced “sisk.” The traditional architecture of a computer that uses microcode to execute very comprehensive instructions. Instructions may be variable in length and use all addressing modes, requiring complex circuitry to decode them.

D

DMA (Direct Memory Access) Specialized circuitry or a dedicated microprocessor that transfers data from memory to memory without using the CPU. Although DMA may periodically steal cycles from the CPU, data are transferred much faster than using the CPU for every byte of transfer.

DoD (Department of Defense) The military branch of the U.S. government, which is under the direction of the Secretary of Defense, the primary defense policy adviser to the President.

DSL (Digital Subscriber Line) A technology that dramatically increases the digital capacity of ordinary telephone lines (the local loops) into the home or office. DSL speeds are tied to the distance between the customer and the telco central office (CO). DSL is geared to two types of usage. Asymmetric DSL (ADSL) is for Internet access, where fast downstream is required, but slow upstream is acceptable. Symmetric DSL (SDSL, HDSL, etc.) is designed for short haul connections that require high speed in both directions.

DSLAM (DSL Access Multiplexer) A central office (CO) device for ADSL service that combines voice traffic and DSL traffic onto a customer's DSL line. It also separates incoming phone and data signals and directs them onto the appropriate carriers network.

E

EDC/ECC (Error Detection Code/Error Correction Code) A memory system that tests for and corrects errors automatically, very often without the operating system being aware of it. When writing the data into memory, ECC circuitry generates checksums from the binary sequences in the bytes and stores them in an additional seven bits of memory for 32-bit data paths or eight bits for 64-bit paths. When data are retrieved from memory, the checksum is recomputed to determine if any data bits have been corrupted. Such systems can typically detect and automatically correct errors of one bit per word and can detect, but not correct, errors greater than one bit.

F

FPGA (Field Programmable Gate Array) A type of gate array that is programmed in the field rather than in a semiconductor fabrication facility. Containing up to hundreds of thousands of gates, there are a variety of FPGA architectures on the market. Some are very sophisticated, including not only programmable logic blocks, but programmable interconnects and switches between the blocks. The interconnects take up a lot of FPGA real estate, resulting in a chip with very low gate density compared to other technologies.

H

HDD (Hard Disk Drive) The primary computer storage medium, made of one or more aluminum or glass platters, coated with a ferromagnetic material. Most hard disks are "fixed disks," which have platters that reside permanently in the drive.

I

I/O (Input/Output) Transferring data between the CPU and a peripheral device. Every transfer is an output from one device and an input into another.

IDE (Integrated Drive Electronics) A type of hardware interface widely used to connect hard disks, CD-ROMs and tape drives to a PC. IDE was always the more economical interface, compared to SCSI. Starting out with 40MB capacities years ago, 40GB IDE hard disks have become entry level, costing a fraction of a cent per megabyte.

IO (Input/Output; see I/O)

L

LBA (Logical Block Addressing) A method used to support IDE hard disks larger than 504MB (528,482,304 bytes) on PCs. LBA provides the necessary address conversion in the BIOS to support drives up to 8GB. BIOS after mid-1994, which are sometimes called "Enhanced BIOS," generally provide LBA conversion. LBA support is required for compatibility with the FAT32 directory.

LSB (Least Significant Byte) "Byte" defines a sequence of 8-bits, with the right-most bit being the least significant and the left-most bit being the most-significant.

LSW (Least Significant Word) "Word" denotes sequence of 4 bytes, or 32 bits, with the left-most being the least significant, and the right-most being the most significant. "Double-word" denotes sequence of two words, or 64 bits, with the left most word being the least significant, and the right-most - the most significant. Note, that the definition of "word" defines a little-endian scheme, so for big-endian platforms, or network applications, special steps need to be taken to reorder the bytes from the input stream.

M

MLC (Multi-Level Cell) A flash memory technology that stores more than one bit of data per cell. Traditional flash memory defines a 0 or 1 bit according to a single voltage threshold. The patterns of two bits (0-0, 0-1, 1-0, and 1-1) can be achieved with four voltage levels and eight levels of voltage can yield all the combinations in three bits.

MSB (Most Significant) "byte" defines a sequence of 8-bits, with the right-most bit being the least significant and the left-most bit being the most-significant.

MSW (Most Significant Word) "Word" denotes sequence of 4 bytes, or 32 bits, with the left-most being the least significant, and the right-most being the most significant. "Double-word" denotes sequence of two words, or 64 bits, with the left most word being the least significant, and the right-most - the most significant. Note, that the definition of "word" defines a little-endian scheme, so for big-endian platforms, or network applications, special steps need to be taken to reorder the bytes from the input stream.

N

NAND (Not AND) A Boolean logic operation that is true if any single input is false. Two-input NAND gates are often used as the sole logic element on gate array chips, because all Boolean operations can be created from NAND gates.

P

PIO (Programmed Input/Output) The data transfer mode used by IDE drives. PIO modes use the CPU's registers for data transfer in contrast with DMA, which transfers directly between main memory and the peripheral device.

R

RISC (Reduced Instruction Set Computer) A computer architecture that reduces chip complexity by using simpler instructions. RISC compilers have to generate software routines to perform complex instructions that were previously done in hardware by CISC computers. In RISC, the microcode layer and associated overhead is eliminated.

S

SATA (Serial AT Attachment) The evolution of the ATA (IDE) interface that changes the physical architecture from parallel to serial and from master-slave to point-to-point. Unlike parallel ATA interfaces that connect two drives; one configured as master, the other as slave, each Serial ATA drive is connected to its own interface.

SLC Single-Level Cell A flash memory technology that stores one bit of data per memory cell; supporting only two states: erased (1) or programmed (0).

SMART (Self-Monitoring Analysis and Reporting Technology) An “early warning system” for anticipating pending drive problems. The drive’s integrated controller works with various sensors to monitor several aspects of the drive’s performance. Using this status information, SMART determines if the drive is behaving normally or not, and then makes the information available to software that probes the drive.

SSD (Solid State Disk) A disk drive that uses memory chips instead of rotating platters for data storage. Used in battery-powered handheld devices as well as desktop computers and servers, solid state disks (SSDs) are faster than regular disks because there is zero latency (there is no read/write head to move). They are also more rugged than hard disks and offer greater protection in hostile environments.

T

True-IDE Flash memory devices (such as CF cards) have a pin that when connected to the proper voltage at power-up selects the “True-IDE” mode of operation instead of the “PC-CARD-ATA” mode of operation. This is the mode used in the interface.

U

Ultra ATA An enhanced version of the IDE interface that transfers data at 33, 66 or 100 Mbytes/sec. These enhancements are also called “Ultra DMA,” “UDMA,” “ATA-33,” “ATA-66,” “ATA-100,” “DMA-33,” “DMA-66” and “DMA-100.”

Ultra DMA (see Ultra ATA)

INDEX

A

Altitude	
High Altitude Limit	50
Low Altitude Limit	50

ATA Commands

ATA Command Flow	20
Overview	20
Standard ATA Commands	21
Vendor-Specific	44

ATA Operating Modes

DMA	10
PIO	10
Serial ATA	10

Audience

OEMs	1
system designers	1
system engineers	1

C

Certification	77
---------------------	----

Commerical Standards	4
----------------------------	---

Compliance

BSMI (Taiwan)	62
Canadian (CSA)	62
CE Marking (CE)	62
Commercial	4
C-TICK (Australia)	62
European Union (EU)	62
FCC	62
MIC (Korea)	62
TUV/SEMKO/UL	62
Underwriters Laboratories (UL)	62
VCCI (Japan)	62

Contact Information	66
---------------------------	----

Conventions

CAUTION	iii
ESD	iii
NOTE	iii
SHOCK HAZARD	iii
TIP	iii

Copyright Notice	ii
------------------------	----

D

Declaration of Conformity	63
---------------------------------	----

Disclaimer of Liability	ii
-------------------------------	----

E

Electrical Specifications

Activity LED Indicator	13
Drive Power-On Ready Time	14
Grounding	14
Hardware Purge	14
Power Consumption	13
Power Mode at Power On	14
Power Requirements	13

Electromagnetic Compatibility	3
-------------------------------------	---

Electromagnetic Susceptibility	3
--------------------------------------	---

Environmental Characteristics

Conformal Coating	52
Non-Operating	50
Operating Temperatures	49
Overview	49
RoHS Directive	51

Errors

Recoverable Data	10
Unrecoverable Data	10

Export Administration Regulation	ii
--	----

F

FCC	77
-----------	----

Functional Blocks

NAND Flash Memory	19
SATA Interface Block	16
SATA Interface Connector	16
SSD Control Block	19

I

Installation

Diagnostic Software	61
ESD Warning	60
NAND Flash Support	61
Operating System Specifications	61
Shock Hazard	53
System Requirements	53

Interface Specifications

Functional Blocks	16
Identify Drive Information	31
SSD Operation	15

M

Military Information Systems

Security Standards	3
--------------------------	---

N

Non-Operating Requirements

Max Temperature Gradient	50
Max. Wet Bulb	50
Relative Humidity	50
shipment	50
Short Duration Temp.	50
storage	50
Temperature Range	50

O

Operating Requirements

ambient air temperature	49
Case Temperature	49
Max. Temperature Gradient	49
Maximum Wet Bulb	49
Relative Humidity	49
Short Duration Temperature	49

Operating Systems

DRMK DOS	61
MS-DOS	61
Red Hat Linux 2.1	61
Red Hat Linux 3.0	61
Windows 2000	61
Windows 2000 Server	61
Windows 2003	61
Windows XP	61
WindowsPE	61

Optional Features

Sanitization	7
SMART Status Monitoring	7

Order Information

P

Performance Characteristics

Bad-Block Management	9
Data Retention	9
Endurance	9
Wear-Leveling Algorithm	9

Physical Characteristics

Drive Assembly Weight	46
Exterior Dimensions	47
Materials	46
SATA Connector Location	48
Storage Capacities	46

Power Saving Commands

Check Power Mode	14
------------------------	----

Idle	14
Sleep	14
Standby	14
Standby Immediate	14

Product Description

Data Security	8
Drive Capacities	8
General	8
Performance	8
SATA Interface	8

Purge Times

Basic Purge	12
Intelligent Destructive Purge	12
MilPurge	12
RapidPurge	12

R

Reference Documents

NCITS 1510D	4
NCITS T13 1697D	4
NCITS T13 1699D	4

Regulatory Compliance

CB Certificate	63
CB Report	63
Electrostatic Discharge	65
EMI Test Site	64
Radio Frequency Emissions	64
Radio Frequency Immunity	64
Verification Samples	64
Verification Testing	64

Relative Humidity

Max Relative Humidity Gradient	50
Maximum Wet Bulb Temperature	50
Relative Humidity Range	50

Reliability

"Hot Plugging"	12
ATA Modes	10
Built-In Self Test	10
Cache Operations	11
Data Transfer Rates	11
Erase Cycles	10
Error Correcting Code (ECC)	10
Error Detection Code (EDC)	10
Error Rates	10
Mount Time	11
Preventative Maintenance	12
Purge Times	12
Repairs	12
Seek Time	11

S

Sanitization Standards	45
------------------------------	----

Sanitize Erase/Fill	44
---------------------------	----

SATA Connector

Power Segment	17
Signal Segment	16

Scope

Electrical Specifications	2
Environmental Characteristics	2
Installation	2
Interface Specifications	2
Manual Overview	1
Optional Features	2
Performance Characteristics	2
Physical Characteristics	2
Product Description	2
Reference Documents	2
Regulatory Compliance	2
Standard Features	2
Standards	2

Shock	Recalibrate	26
Drop Test	Security Disable Password	26
SMART	Security Erase Prepare	26
SMART Attributes	Security Erase Unit	26
SMART Commands	Security Freeze Lock	26
SMART Support	Security Set Password	26
SSD Control Block	Security Unlock	26
FPGA Controller	Seek	27
NAND SLC Flash Memory	Set Features	27
Overview	Set Multiple Code	27
RISC Microcontroller	Set Sleep Mode	27
Standard ATA Commands	Sleep	27
Check Power Mode	SMART	27
Download Microcode	Standby	27
Erase Sector	Standby Immediate	28
Execute Drive Diagnostic	Write Buffer	28
Flush Cache	Write DMA	28
Flush Cache Ext.	Write DMA Ext	28
Format Track	Write DMA FUA Ext	28
Identify Response	Write DMA Queued	28
Idle	Write DMA Queued Ext	28
Idle Immediate	Write DMA Queued FUA Ext	28
Initialize Drive Parameters	Write Multiple	29
NOP (00h)	Write Mult FUA Ext	29
Read Buffer	Write Multiple Ext	29
Read DMA	Write Sector(s)	29
Read DMA Ext	Write Sector(s) Ext	29
Read DMA Queued	Standard Features	
Read Mult. Ext	Compliance	6
Read Multiple	Endurance	5
Read Read DMA Queued Ext	Environmental	6
Read Sector(s) Ext	Interface	5
Read Sectors	Performance	5
Read/Verify Ext	Physical Characteristics	6
Read/Verify Sector(s)	Power	7

Reliability	5
Unformatted Capacities	5
System POST, Boot and Resume ...	61
System Requirements	
Connector Requirements	54
Cooling Requirements	57
Drive Configuration	53
Drive Installation	60
Drive Orientation	55
Grounding	60
mounting holes	58
mounting screws	59
Primary Heat Generation	56
SATA Connections	53
T	
Trademark Information	ii
V	
Vibration	
Random	51
W	
Warranty	
Limited	77
Modifications	77

CERTIFICATION AND WARRANTY

FCC Declaration of Conformity



The Zeus SATA Solid State Drive carries the FCC-Mark in accordance with related Federal Communications Commission (FCC)–USA directives. This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- This device may not cause harmful interference.
- This device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Re-orient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/television technician for help.

Modifications made to this device that are not approved by STEC may void the authority granted to the user by the FCC to operate this equipment.

Limited Warranty

STEC Inc. ("STEC") SATA Solid State Drives ("SSD") are warranted against defects in material and workmanship, and will operate in substantial conformance with their respective specifications under normal use and service for a period of five (5) years from the date of shipment. Subject to the conditions and limitations set forth below, STEC will, at its own option, either repair or replace any defective SSD Product that proves to be defective by reasons of improper workmanship or materials, if buyer notifies STEC of such failure within the stated warranty period. Products repaired or replaced during the applicable warranty period shall be covered by the foregoing warranties for the remainder of the original warranty period or ninety (90) days from the date of reshipment, whichever is longer. Parts used to repair products or replacement products may be provided by STEC on an exchange basis, and will be either new or refurbished to be functionally equivalent to new.

STEC DISCLAIMS ALL OTHER WARRANTIES, EITHER EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, WITH RESPECT TO ITS PRODUCTS AND ANY ACCOMPANYING WRITTEN MATERIALS. FURTHER, STEC DOES NOT WARRANT THAT SOFTWARE WILL BE FREE FROM DEFECTS OR THAT ITS USE WILL BE UNINTERRUPTED OR REGARDING THE USE, OR THE RESULTS OF THE USE OF THE SOFTWARE IN TERMS OF CORRECTNESS, ACCURACY, RELIABILITY OR OTHERWISE.

STEC is not responsible for updates or functionality of third-party software. Software is provided with notices and/or licenses from third parties which govern your use.

Modifications

Any changes or modifications made to this device that are not expressly approved by STEC will void the user's warranty. All wiring external to the product should follow the provisions of the current edition of the National Electrical Code.



61000-03258-101; Release 1.5

STEC Inc.

World Headquarters

3001 Daimler Street
Santa Ana, CA 92705 USA

Tel: 949.476.1180

Fax: 949.476.1209

Web: www.stec-inc.com

Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

STEC:

[Z6S224I](#) [Z6S224C](#) [Z4S232I](#) [Z8S280C](#) [Z4S264C](#) [Z4S264I](#) [Z8S280I](#) [Z6S248I](#) [Z6S212I](#) [Z6S248C](#) [Z4S216I](#)
[Z4S28I](#) [Z4S216C](#) [Z6S212C](#) [Z4S28C](#) [Z8S2128I](#) [Z4S232C](#)