Product Specification

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CloudSpeed Ascend and CloudSpeed Ultra 2.5" SATA Solid State Drive Generic

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a Western Digital brand

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Revision History

Date	Revision	Section(s)	Description
June 2016	3	All	Western Digital corporate branding applied. No technial information changed.
March 2015	2	1.1, 1.2, and 1.4.1	Updates to performance numbers.
April 2014	1	All	Initial release.

Caution – Handling

Static electricity may be discharged through this disk subsystem. In extreme cases, this may temporarily interrupt the operation or damage components. To prevent this, make sure you are working in an ESD-safe environment. For example, before handling the disk subsystem, touch a grounded device, such as a computer case.

1.0 General Description

1.1 Overview

The SanDisk CloudSpeed™ solid state drive (SSD) product family is designed specifically to address the growing need for SSDs that are optimized for mixed workload applications in enterprise server and cloud computing environments. Leveraging SanDisk's proprietary Guardian Technology™ Platform, tier-one OEM-enterprise firmware, proven power fail technology, and the latest generation of consumer Multi-Level Cell (MLC) NAND flash, the CloudSpeed SSD product family offers all the features expected from an enterprise-class drive at the right value.

Available in capacities of 100–960 GBytes, the CloudSpeed SSD product family features a 6 Gbits/sec Serial Advanced Technology Attachment (SATA) interface and provides up to 468–450 MBytes/sec sequential read/write and up to 76–33.8 K Input/Output Operations Per Second (IOPS) random read/write performance.

The CloudSpeed product family is powered by SanDisk's proprietary Guardian Technology Platform™, a comprehensive suite of innovative features comprised of FlashGuard™, DataGuard™, and EverGuard™ technologies.

FlashGuard extends the native endurance of Multi-Level Cell (MLC) flash-based products. It combines Aggregated Flash Management, which treats all flash elements as a single system, and Advanced Signal Processing, which dynamically adjusts flash parameters throughout the life of the SSD. Using these features, with proprietary-enhanced error-correction techniques, FlashGuard technology provides the endurance enhancements required to enable the use of MLC flash in mission-critical enterprise applications.

CloudSpeed implements data path protection using a comprehensive set of features, including:

- ECC and parity protection on internal data path memories
- CRC protection on internal SATA link data paths
- ECC on data resident in flash
- Flexible Redundant Array of Independent Memory Elements (FRAME) block-level flash data recovery/redundancy

EverGuard protects against loss of user data in the event of unexpected power interruptions using a third-generation backup power circuit design and high-reliability discrete capacitors.

SanDisk has built its foundation by providing proven technology and quality products to the most demanding Fortune 100 OEMs. SanDisk engineers its products to perform at the highest degree of reliability and compatibility.

1.2 Features

- **Type:** 2.5" SATA SSD
- **Interface:** Compatible with the SATA 3.1, 6 Gbits/sec Standard
- **Capacities:**
  - CloudSpeed Ascend: 120 GBytes, 240 GBytes, 480 GBytes, and 960 GBytes
  - CloudSpeed Ultra: 100 GBytes, 200 GBytes, 400 GBytes, and 800 GBytes
- **Data Rates[1]:**
  - **CloudSpeed Ascend:**
    - **Read/Write, Sequential[1]:** Up to 468/450 MBytes/sec
    - **Read/Write, Random[2]:** Up to 76,000/14,800 IOPS
  - **CloudSpeed Ultra:**
    - **Read/Write, Sequential[2]:** Up to up to 468/450 MBytes/sec
    - **Read/Write, Random[3]:** Up to 75,000/33,800 IOPS
- **Access Time:** <2.0 msec
- **Operating Temperature[4]:** 0 °C to 70 °C (internal)
- **Compliance:**
  - RoHS
  - Halogen-free
- **Warranty:** 5 years

1. Max performance is possible on the largest capacity point only.
2. Based on 4 KByte transfers. Final numbers are pending evaluation.
3. Based on 4 KByte transfers. Final numbers are pending evaluation.
4. As measured by internal drive thermal sensors.

1.3 Unique Features

- Drive-specific SMART Attributes
- FlashGuard Technology
  - Extended Endurance of MLC Flash
  - Aggregated Flash Management
  - Advanced Signal Processing
  - Enhanced Error Correction
- DataGuard Technology
  - Protects Against Data Corruption and Loss
  - FRAME Technology
- EverGuard Technology
  - Data Protection in the Event of Unanticipated Power Outages
  - High-reliability Backup Power Circuitry
- Superior Reliability
- Full Data Path Protection
- Temperature Throttling
- Field Upgradeable Firmware (Through the SATA Interface)

1.4 Operational Characteristics

All listed values are typical unless otherwise stated.

1.4.1 Performance

Table 1: Performance Characteristics

Characteristic	CloudSpeed Ascend Performance	CloudSpeed Ultra Performance
Sequential Read (Maximum)	Up to 468 MBytes/sec	Up to 468 MBytes/sec
Sequential Write (Maximum)	Up to 450 MBytes/sec	Up to 450 MBytes/sec
Random Read IOPS (Maximum)	Up to 76,000 IOPS[5]	Up to 75,000 IOPS[5]
Random Write IOPS (Maximum)	Up to 14,800 IOPS[5]	Up to 33,800 IOPS[5]
Access Time	< 2.0 msecs	< 2.0 msecs

1.4.2 Reliability

Table 2: Reliability Characteristics

Characteristic	Model	Value
Data Reliability	All CloudSpeed Configurations	<1 in 10^{17} bits read[6]
Data Retention	All CloudSpeed Configurations	1 year @ 0% P/E cycles; 3 months @ 100% P/E cycles[7]
Endurance (Random/ Sequential Workload)	CloudSpeed Ascend	1/6 DWPD (Random/Sequential Workload) for 5 years[8]
	CloudSpeed Ultra	3/7 DWPD (Random/Sequential Workload) for 5 years[8]

1.4.3 Power

Table 3: Power Requirements[9]

Parameter	Value (Typical)	Value (Max)	Unit
V_{IN}	5.0	5.5	V
Read	3.5	4.5	W
Write	5.2	6.0	W
Idle	2.2	3.0	W

5. Random performance values are based on 4 KByte transfers. Final numbers are pending design verification testing (DVT).

6. The JEDEC 64.8 specification requires 1 in 10^{16} for enterprise-class SSDs.

7. Three-month data retention is based on operating and storage temperatures not to exceed 40 °C.

8. Application must manage Drive Writes Per Day (DWPD) throughout the life of the drive to ensure the five-year lifetime for specific workloads. For details about how this is calculated, please reference SanDisk White Paper WP004, *The Why and How of SSD Over Provisioning*.

9. Power measurements were taken on highest capacity drive with worst case workload condition. Lower capacities will have lower drive power. Results reflect average power.

1.5 Environmental Conditions

Table 4: Environment Tests

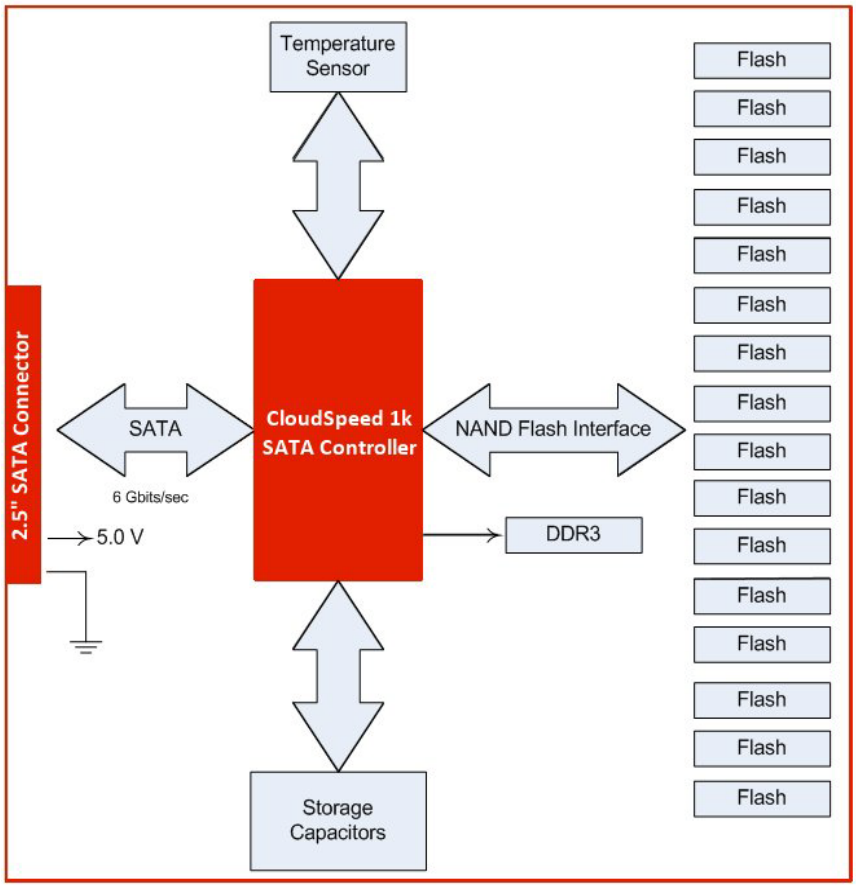
Test	Condition	Limits
Altitude	Operating	-200 feet to 10,000 feet
	Shipping	-200 feet to 40,000 feet
	Storage	-200 feet to 40,000 feet
Temperature and Humidity	Operating	Temperature: 0 °C to 70 °C (internal) Humidity: 5% to 95% non-condensing, relative humidity **NOTE:** Warranty coverage is voided for drives that record temperatures in excess of 70 °C.
	Shipping/Storage	Temperature: -40 °C to 95 °C Humidity: 5% to 95% non-condensing, relative humidity **NOTE:** Non-operational exposure to temperatures in excess of 40 °C for periods exceeding three months should be avoided. The three-month EOL data retention specification requires storage temperatures do not exceed 40 °C. If necessary, contact SanDisk for further information.
Vibration	Operating	2.17 *g* rms, 7-800 Hz, 10 min per axis
	Non-operating	16.3 *g* rms, 20-2000 Hz, 30 min per axis
Shock	Operating	1000 *g* @ 1.0 msec, one shock along each axis (x, y, and z) in each direction
	Non-operating	1500 *g* @ 5 msec, one shock along each axis (x, y, and z) in each direction
Common Mode Noise	– – –	220 mV 10 KHz - 10 MHz
V_{cc} Ripple Noise	– – –	50 mV, 10 KHz - 50 KHz 100 mV, 50 KHz - 10 MHz

2.0 Product Description

The CloudSpeed SSD contains a NAND flash controller that provides a 6 Gbits/sec SATA interface to the host. Parallel access to multiple flash sites allows overlapped, multi-block access to complete data transfer requests rapidly. A thermal sensor provides input to the controller regarding over-temperature conditions. The backup power circuitry feature provides a hold up capacitor array to ensure data integrity during power fail scenarios.

2.1 Functional Block Diagram

Figure 1: CloudSpeed Block Diagram



2.2 Flash Management

The CloudSpeed supports the following techniques for enhanced flash management:

- **Static Wear Leveling:** This feature eliminates overstressing flash media by spreading the data writes across all flash physical address space, including logical areas that are not written by the user.
- **ECC:** The CloudSpeed utilizes advanced two-level BCH code and a Flexible Redundant Array of Memory Elements (FRAME) data recovery algorithm. The drive activates this second tier of error correction if the ECC engine is unable to correct the data located in failed NAND pages.
- **Bad-block Management:** This feature tracks all manufacturing and run-time bad blocks of flash media and replaces them with new ones from the spare pool.
- **Data Retention Management:** As flash is used over the life of the drive, data retention capability declines. The CloudSpeed incorporates multiple data-retention management techniques to ensure the highest data reliability and integrity, even towards the end of the drive life.
- **Minimal Write Amplification:** Write amplification is defined as the ratio of total data written to the flash compared to the total data written by the host. This ratio varies continually as a function of workload. The CloudSpeed controller utilizes write optimization, effective wear leveling, intelligent bad-block management, and efficient recycling to deliver an unprecedented, low write amplification factor. This translates directly to higher and more stable performance over a longer life.

2.3 Endurance

The CloudSpeed SSDs provide the innovative FlashGuard technology feature to extract higher endurance from MLC flash. FlashGuard incorporates two important technology breakthroughs in the area of flash and SSD system management:

- Aggregated Flash Management
- Advanced Signal Processing

2.3.1 Aggregated Flash Management

SanDisk's Aggregated Flash Management technology prolongs the life of SSDs by treating all flash elements in the SSD as a system instead of as a collection of discrete elements. Aggregating the management of the flash over multiple pages within a block and over multiple blocks within the SSD reduces the limitations imposed at the page and block levels, thus extending the life of the drive.

FlashGuard treats each flash cell individually, thereby maximizing the effects of stronger flash elements (i.e., those that exhibit higher performance capability) while minimizing the effects of weaker elements. The capability of FlashGuard to distinguish between and take advantage of flash elements at the cellular level extends the endurance of the drive.

2.3.2 Advanced Signal Processing

The controller's Advanced Signal Processing technology periodically monitors the flash and collects detailed performance statistics. This information is used to dynamically adjust the flash operating parameters for maximum endurance from the drive throughout its operational life. To further extend the life of the drive, FlashGuard incorporates a proprietary enhanced error correction technology that corrects more data errors than is possible with standard error correction schemes.

2.4 Temperature Throttling

The CloudSpeed SSDs support temperature throttling to guarantee the life of the drive. With this feature, the drive throttles the drive performance based on a pre-configured temperature level of 65 °C, which is measured by the drive thermal sensor. When the critical temperature (65 °C) is reached, the drive throttles write performance and trips the Drive Temperature Warning SMART attribute (ID 190). Performance remains throttled until the temperature falls to 63 °C or below.

NOTE:	The throttling level varies depending on the current workload.

2.5 Mean Time Between Failures (MTBF)

The MTBF statistic for CloudSpeed is calculated based on the MIL-HDBK-217 standard.

Table 5: MTBF Values

Drive Capacity	MTBF (Hours)
All	>2,500,000

2.6 Regulatory Standards Compliance

Table 6: Regulatory Agency Approvals

Category	Region	Compliance/Agency	Standard	Additional Information
Safety	USA	UL	UL 60950-1, Second Edition	UL File No. E351027
	Canada	CSA	CSA C22.2 No. 60950-1-07, Second Edition	CSA Certificate
	Korea	EMI	KN22, KN24	KCC Certificate
	Taiwan	EMI	CN 13438	
SATA		SATA-IO	SATA Revision 1.4 Interoperability testing	
RoHS	European Union	EU Directive 2011/65/EU (RoHS)	N/A	
EMC	USA	FCC	FCC Part 15 Class B	FCC Declaration of Conformity
	Canada	Industry Canada	ICES-0030 Class B	IO Declaration of Conformity
	European Union	EU Directive 2004/108/EC (EMC)	EN 55022-2010 Class B	CE Declaration of Conformity
	Korea	KCC	KN22:2009 Class B, KN24:2009	KCC Certificate
	Taiwan	BSMI	CN 13438 (2006)	BSMI Declaration of Conformity
	Australia	ACMA	AS/NZS CISPR22-2006, Class B	C-Tick Declaration of Conformity

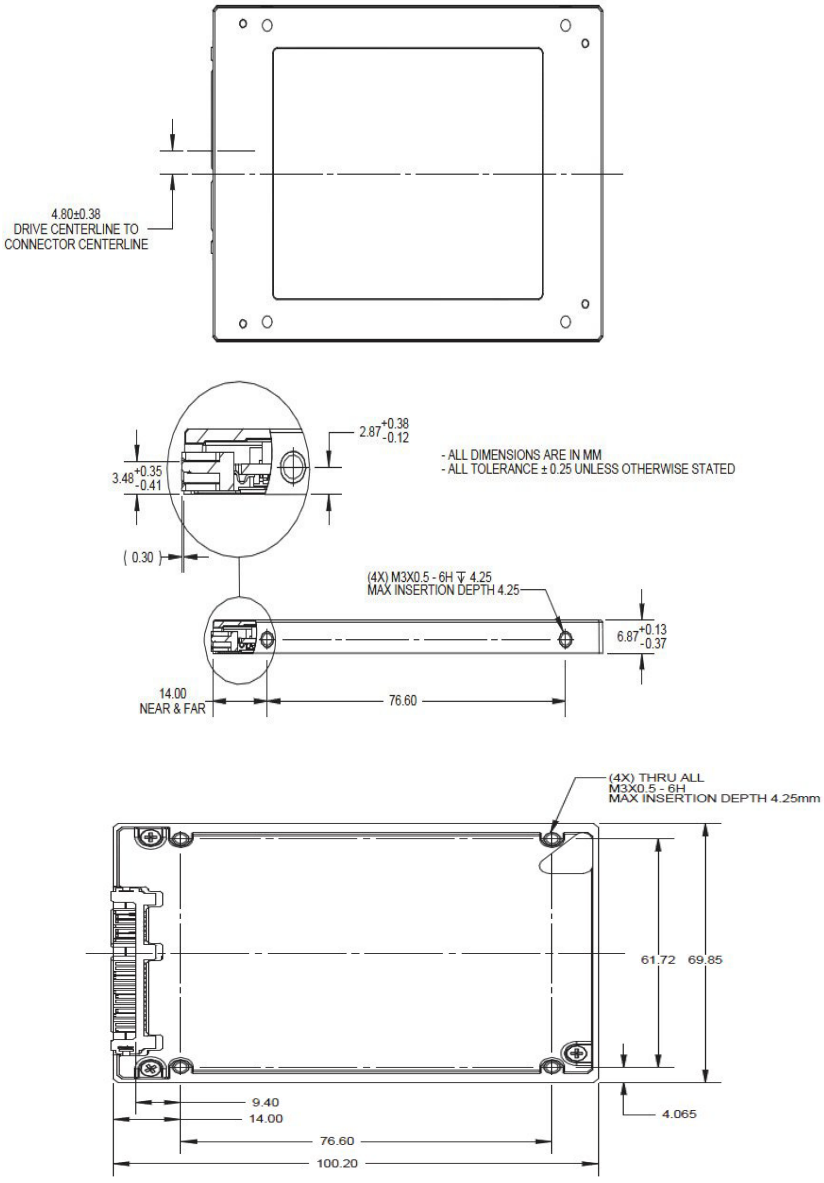
3.0 Mechanical Specifications

3.1 Physical Specifications

Table 7: Physical Characteristics

Parameter	Value
Height (Mounted)	7.00 mm (maximum)
Width	69.85 mm (nominal)
Length	100.20 mm (nominal)
Weight	89.90 g (maximum)

Figure 2: CloudSpeed Drive Dimensions (in mm)



NOTE:	The warranty is voided if the label is removed.

4.0 Electrical Specifications

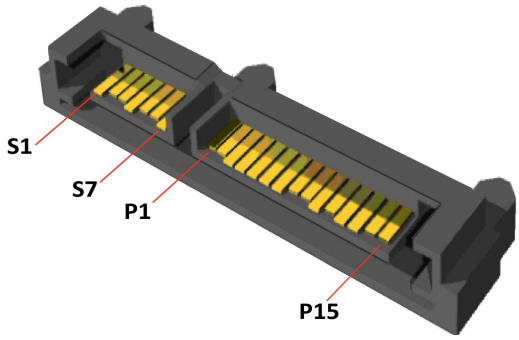
4.1 Electrical Interface

The CloudSpeed SSD is compliant with the SATA 3.0, 6.0 Gbits/sec standard.

4.1.1 CloudSpeed Interface Connector

The SATA connector on the CloudSpeed SSD includes a signal bay (S1 to S7) and a power bay (P1 to P15). The SATA connector can support both cabled and backplane plug-in connections. The connector complies with the Telcordia GR-78 standard (NEBS), meeting the minimum requirement of 30 µinches of gold over a nickel base of 50 µinches.

Figure 3: SATA Connector for the CloudSpeed SSD



4.1.2 Pinout Description-Power Pinout Descriptions

Table 8: Signal Pinout Descriptions

Pin	Signal Name	In/Out	Signal Description
S1	GND	N/A	2nd mate
S2	Dev Rx+	In	Receive differential pair signal in +
S3	Dev Rx-	In	Receive differential pair signal in -
S4	GND	N/A	2nd mate
S5	Dev Tx-	Out	Transmit differential signal out -
S6	Dev Tx+	Out	Transmit differential signal out +
S7	GND	N/A	2nd mate

Table 9: Power Pinout Descriptions

Pin	Signal Name	In/Out	Signal Description
P1	V3.3	N/A	3.3 V power (not used)
P2	V3.3	N/A	3.3 V power (not used)
P3	V3.3	N/A	3.3 V power (not used)

Table 9: Power Pinout Descriptions (Continued)

Pin	Signal Name	In/Out	Signal Description
P4	GND	In	1st mate
P5	GND	In	2nd mate
P6	GND	In	2nd mate
P7	V5	In	5 V power, pre-charged, 2nd mate
P8	V5	In	5 V power
P9	V5	In	5 V power
P10	GND	In	2nd mate
P11	Reserved	In/Out	Activity indicator
P12	GND	In	1st mate
P13	V12	N/A	12 V power (not used)
P14	V12	N/A	12 V power (not used)
P15	V12	N/A	12 V power (not used)

4.2 Remote LED

In compliance with the SATA standard, pin P11 on the SATA 15-pin power connector supports a remote LED. Because the signal is not suitable for directly driving an LED, a circuit external to the device must first buffer the signal. When connected, the remote LED indicates activity. Refer to the SATA standard for more details.

4.3 Thermal Sensor

The CloudSpeed SSD contains a thermal sensor on the printed circuit board. The sensor polls the drive for temperature information every 60 seconds, and the drive stores the highest and lowest readings in the drive logs. This temperature represents the temperature of the printed circuit board, not the drive case.

5.0 Absolute Maximum Ratings

Table 10: Absolute Maximum Ratings

Symbol	Parameter	Ratings (Max)	Unit
V_{IN}	5 V Supply Voltage	5.5	V
I_{ACTIVE}	Active Current	1.2	A
T_{STG}	Storage Temperature	-40 to 95	°C

5.1 Recommended Operating Conditions

Table 11: Recommended Operating Conditions

Symbol	Parameter	Ratings	Unit
V_{IN}	5 V Supply Voltage	5 / -10%	V
T_A	Operating Temperature (Internal)	0 to 70	°C

5.2 DC Characteristics

Table 12: DC Characteristics

Symbol	Parameter	Average	Peak	Unit	Condition
I_{READ}	Active Read Current	0.70	0.90	A	V_{IN} = 5 V
I_{WRITE}	Active Write Current	1.04	1.20	A	V_{IN} = 5 V
I_{IDLE}	Idle Current	0.44	0.60	A	V_{IN} = 5 V

6.0 Software Specifications

6.1 Enterprise SATA Implementation

SSD firmware implements all features required of enterprise drives.

Table 13: Supported ATA Commands

Command Name	Op Code (Hex)	Command Set (Category)
Check Power Mode*	E5	Power Management
Data Set Management	06	General
Download Microcode	92	General
Execute Drive Diagnostic	90	General
Flush Cache	E7	General
Flush Cache Extended (see Set Features Sub commands on page 22)	EA	48-Bit Address
Identify Device	EC	General
Idle*	E3	Power Management
Idle Immediate*	E1	Power Management
NOP	00	General
Read Buffer PIO	E4	General
Read DMA	C8	General
Read DMA Extended	25	48-Bit Address
Read DMA w/o Retries	C9	General
Read FPDMAQ	60	NCQ
Read Log	2F	GPL
Read Log DMA Extension	47	48-Bit Address
Read Long w/o Retries	23	General
Read Multiple - PIO Multiple Read/Write	C4	General
Read Multiple Ext - PIO Multiple Read/Write	29	48-Bit Address
Read Native Max Address	F8	HPA
Read Native Max Address Extended	27	48-Bit Address
Read Sectors - PIO	20	General
Read Sectors Extended - PIO	24	48-Bit Address
Read Sectors - PIO	21	General
Read Verify Sectors	40	General
Read Verify Sectors Extended - PIO	42	48-Bit Address
Recalibrate	10	General

Table 13: Supported ATA Commands (Continued)

Command Name	Op Code (Hex)	Command Set (Category)
Sanitize Device	B4	General
Security Erase Prepare	F3	Security
Security Erase Unit	F4	Security
Security Freeze Lock	F5	Security
Security Set Password	F1	Security
Security Unlock	F2	Security
Seek	70	General
Send FPDMA Queued	65	NCQ
Set Features (see Set Features Sub commands on page 22)	EF	General
Set Max Address	F9	HPA
Set Max Address Extended	39	48-Bit Address
Set Multiple Count - PIO Multiple Read/Write	C6	General
Sleep*	E6	Power Management
SMART Operations	B0	SMART
Standby*	E2	Power Management
Standby Immediate*	E0	Power Management
Write Buffer DMA	E8	General
Write DMA	CA	General
Write DMA Extended	35	48-Bit Address
Write DMA w/o Retries	CB	General
Write FPDMAQ	61	NCQ
Write Log	3F	GPL
Write Log DMA Extended	57	48-Bit Address
Write Long	32	General
Write Long w/o Retries	33	General
Write Multiple - PIO Multiple Read/Write	C5	General
Write Multiple Extended - PIO Multiple Read/Write	39	48-Bit Address
Write Sectors	30	General
Write Sectors w/o Retries	31	General
Write Sectors Extended - PIO	34	48-Bit Address
Write Uncorrectable Extended	45	General

* The SSD accepts these commands and returns a good status, but does not execute the commands.

Table 14: Identify Device Information

Word(s)	Data	Description
0	5A0Ch	General configuration; bit-significant information
1-6	3FFFh, C837h, 0010h, 0000h, 0000h, 003Fh	Obsolete/retired/specific
7-8	0000h	Reserved CompactFlash™
9	0000h	Retired
10-19	XXXXh	20-character serial number in ASCII
20-22	00004, 000h, 0032h	Retired/obsolete
23	XXXXh	Firmware revision (8 ASCII characters)
27	[Manufacturer's Info]	Model number
47	8010h	Reserved
48	0000h	TCG feature set options
49	2F00h	Capabilities: IORDY, IORDY (DIS), LBA, DMA supported
50	4001h	Capabilities
51	0000h	Obsolete
53	0007h	Free-fall control sensitivity
54-58	3FFFh, 0010h, 003Fh, FC10h, 00FBh	Obsolete
59	5100h	Reserved
60-61	FFFFh, 0FFFh	Total number of user addressable logical sectors
62	0000h	Obsolete
63	0007h	Reserved
64	0003h	Reserved
65	0078h	Minimum multiword DMA transfer cycle timer per word
66	0078h	Manufacturer's recommended multiword DMA cycle time
67	0078h	Minimum PIO transfer cycle time without flow control
68	0078h	Minimum PIO transfer cycle time with IORDY flow control
69-70	0D10h, 0000h	Reserved
71-74	0000h	Reserved for IDENTIFY PACKET DEVICE command
75	001Fh	Queue depth
76	A70Eh	Serial ATA capabilities
77	0006h	Reserved for future Serial ATA capabilities
78	00C4h	Serial ATA features supported

Table 14: Identify Device Information (Continued)

Word(s)	Data	Description
79	0044h	Serial ATA features enabled
80	01FEh	Major version number
81	0021h	Minor version number
82	746Bh	Commands and feature sets supported
83	7401h	Commands and feature sets supported
84	4163h	Command set/feature supported extension
85	7009h	Command set/feature enabled
86	B401h	Command set/feature enabled
87	4161h	Command set/feature enabled/supported
88	407Fh	Ultra DMA Modes
89-90	0000h	Reserved
91	0000h	Current advanced power management value
92	0000h	Master password revision code
93	0000h	Hardware reset result
94	0000h	Obsolete
95	0000h	Stream minimum request size
96	0000h	Streaming transfer time DMA
97	0000h	Stream access latency; DMA and PIO
98	0000h	Streaming performance granularity
100-103	XXXXh	Total number of user LBA for 48-bit address feature set
104	0000h	Streaming transfer time PIO
105	0000h	Reserved
106	4000h	Physical/Logical sector size
107	0000h	Inter-seek delay for ISO-7779 acoustic testing in µsec
108	5001h, 1731h, XXXXh	WWN
112-115	0000h	Reserved for 128-bit World Wide name extension
116	0000h	Reserved for INCITS TR-37-2004
117-118	0000h	Words per logical sector
119	4058h	Commands and feature sets supported
120	4018h	Commands and feature sets supported or enabled
121-126	0000h	Reserved

Table 14: Identify Device Information (Continued)

Word(s)	Data	Description
127	0000h	Obsolete
128	0001h	Security Status
129-159	0000h	Vendor specific
160	0000h	CFA power mode 1
161-175	0000h	Reserved for assignment by the CompactFlash Association
176-205	0000h	Current media serial number (60 ASCII characters)
206	0000h	SCT command transport
207-208	0000h	Reserved for CE-ATA
209	0000h	Alignment of logical blocks within a larger physical block
210-211	0000h	Write-Read-Verify sector count mode 3 only
212	0000h	Verify sector count mode 2 only
214	0000h	NV cache capabilities
215	0000h	NV cache in logical blocks (LSW)
216	0000h	NV cache in logical blocks (MSW)
217	0001h	Nominal media rotation rate (ATA8-ACS 1699-D Rev 6) NV cache read transfer speed in MBytes/sec (ATA8-ACS 1699-D Revision 3f)
218	0000h	NV cache write transfer speed in MBytes/sec
219	0000h	NV cache options
220	0000h	Write-Read-Verify feature set current mode
221	0000h	Reserved
222	0000h	Transport major revision number
223	0000h	Transport minor revision number
224-233	0000h	Reserved for CE-ATA
234	0000h	Minimum number of 512 byte units per `DOWNLOAD MICROCODE` command mode 3
235	0000h	Maximum number of 512 byte units per `DOWNLOAD MICROCODE` command mode 3
236-254	0000h	Reserved
255	7AA5h	Integrity Word

Table 15: Set Features Sub commands

Features	Decimal	Description
02	2	Enable Write Cache
10	16	Enable Use of Serial ATA Features
55	85	Disable Read Look Ahead
82	130	Disable Write Cache
90	144	Disable Use of Serial ATA Features
AA	170	Enable Read Look Ahead

6.2 Power Throttling

The CloudSpeed SSD supports a power-throttling feature to allow the host system to trade off performance for power dissipation in order to reduce internally generated heat. This feature is not continually variable. Power consumption is primarily a function of flash write activity, and to achieve performance, the CloudSpeed SSD is designed to submit work to multiple flash at the same time. Power can only be adjusted in increments related to this group size.

6.3 Supported SMART Operations

Self-Monitoring Analysis and Reporting Technology (SMART) attributes provide diagnostic information regarding drive operation. SMART alerts the host to potential drive problems, allowing system operators to assess the situation and backup data prior to an operational failure.

With SMART, the CloudSpeed continually monitors a number of key internal operating parameters to identify performance changes which could be a sign of impending drive failure. When the drive detects such a condition, the drive alerts the host system of a reduction in reliability or performance.

Table 16: Supported SMART Attributes

Attr ID (Decimal)	Threshold (Decimal)	Name	Values	Indicates
2	1	Internal File Check		The file check is a test of an internal file system that contains non-volatile data. This should be zero. **Normalized Range**: Best: 0 Worst: 0
5	N/A	Retired Block Count	Raw Usage	The total number of blocks added to the defect list **Normalized Range**: Best: 0 Worst: 0 **Raw Usage**: [5:8]: The total number of retired blocks
9	N/A	POH	1-100 (Normalized)	The total number of hours the drive has had power applied to it since the date of manufacture **Normalized Range:** (normalized and worst values are the same value) Best: 100-1 Worst: 100-1 **Raw Usage:** [5:8]: Total number of power-on hours [9:11]: Total number of seconds since last power-on hour update

Table 16: Supported SMART Attributes (Continued)

Attr ID (Decimal)	Threshold (Decimal)	Name	Values	Indicates
12	N/A	Device Power Cycle Count	1-100 (Normalized)	The number of full Power cycles that have occurred since the date of manufacture **Normalized Range: (normalized and worst values are the same value)** Best: 100-1 Worst: 100-1 **Raw Usage:** [5:8]: Cumulative lifetime power cycle count
13	255	ECC Soft Read Error Rate	120 (Normalized)	The rate of errors correctable by the first level of correction (ECC engine) **Normalized Range**: Best: 120 Worst: 120 **Raw Usage:** [5:8]: Count of correctable ECC errors
32	N/A	Write Amplification	Raw Usage	What is currently being written and what was previously written to the SSD. In order to accurately measure the value, a test should be run for enough time to ensure the drive has reached a steady state condition. **Raw Usage:** [5:8]: The write amplification multiplied by 100 (for example, a write amplification of 1 has a value of 100)
170	N/A	Reserved Block Remaining	Raw Usage	The number of reserved blocks (or spares) remaining **Raw Usage:** [5:8]: The total number of retired blocks
171	N/A	Program Fail Count	Raw Usage	The number of flash program failures that occurred since the date of manufacture **Raw Usage:** [5:8]: Program error count
172	N/A	Erase Fail Count	Raw Usage	The number of flash erase failures that occurred since the date of manufacture **Raw Usage:** [5:8]: Erase error count
173	N/A	Percent Drive Life Used	Raw Usage	The percent drive life used based on the percentage of over-provisioned erase blocks that are defective. This is the complement to attribute ID 177. **Raw Usage:** [5:8]: The percent of drive life used
174	N/A	Unexpected Power Loss Count	Raw Usage	The number of times the drive lost power without first receiving a `Standby Immediate` or `Sleep` command. **Raw Usage:** [5:8]: Unexpected power loss event count

Table 16: Supported SMART Attributes (Continued)

Attr ID (Decimal)	Threshold (Decimal)	Name	Values	Indicates
175	N/A	Power Loss Protection Failure	Raw Usage	The total number of times over the lifetime of the drive when the drive has lost data intended to be written during a power down **Raw Usage:** [5:8] The number of power-loss-protection failures
177	0	Percent Drive Life Remaining	Raw Usage	The percentage of the drive life remaining **Normalized Range**: Best: 0 Worst: 0 **Raw Usage:** [5:8]: Percent of drive life remaining
181	N/A	Program Fail Count	Raw Usage	The number of flash-program failures that occurred since the date of manufacture. This is identical to attribute ID 171. **Raw Usage:** [5:8]: Program error count
182	N/A	Erase Fail Count	Raw Usage	The number of flash-erase failures that occurred since the date of manufacture. This is identical to attribute ID 172. **Raw Usage:** [5:8]: Erase error count
190	65	Drive Temperature Warning	0-100 (Normalized)	Internal SSD temperature. If the current temperature exceeds the threshold value, the drive throttles performance. **Normalized Range**: Best: Current temperature (°C) Worst: Highest lifetime temperature **Raw Usage:** [5:6]: Current temperature (°C) [7]: Lowest temperature recorded since the last power cycle (°C) [8]: Highest temperature recorded since The last power cycle (°C)
194	69	Drive Temperature	0-100 (Normalized)	Internal SSD temperature, including the lowest and highest recorded temperature since the date of manufacture **Raw Usage:** [5:6]: Current temperature (°C) [7]: Highest temperature recorded over the lifetime of the drive (°C) [8]: Lowest temperature recorded over the lifetime of the drive (°C)
195	N/A	Uncorrectable Error Count*	TBD (Normalized)	The total number of uncorrectable errors on reads and writes **Normalized Range**: Best: 120 Worst: 120 **Raw Usage:** [5:8]: Number of uncorrectable errors

Table 16: Supported SMART Attributes (Continued)

Attr ID (Decimal)	Threshold (Decimal)	Name	Values	Indicates
196	N/A	Reallocation Event Count	TBD (Normalized)	Total number of blocks added to the defect list **Normalized Range**: Best: 100 Worst: 100 **Raw Usage:** [5:8]: Total number of grown defects
198	TBD	Offline Scan Uncorrectable Count	Raw Usage	The rate of errors that are uncorrectable by the second level of error correction (FRAME). Currently, this reports zero. **Raw Usage:** [5:8]: TBD (Currently 0)
199	TBD	UDMA CRC Error	Raw Usage	The number of erase blocks that were added to the defect database as both factory and runtime defects **Raw Usage:** [5:8]: TBD (Currently 0)
233	N/A	Reserved	– – –	This attribute is returned with the SMART Read Data command. It is for internal use only and, therefore, is not documented.
241	N/A	Lifetime Bytes Written by Host	Raw Usage	The total amount of data (in GBytes) the host has written to the drive since the date of manufacture. This value starts at zero and increments every 64 GBytes in units of 64. For example, after the first 64 GBytes are reached, the value increments from 0 to 64 (40h). When the next 64 GBytes are reached, the value increments to 128 (80h), and so on. **Raw Usage:** [5:8]: The number of 64 GByte increments written by the host
242	N/A	Lifetime Bytes Read by Host	Raw Usage	This value starts at zero and increments every 64 GBytes in units of 64. For example, after the first 64 GBytes are reached, the value increments from 0 to 64 (40h). When the next 64 GBytes are reached, the value increments to 128 (80h), and so on. **Normalized Range**: Best: 0 Worst: 0 **Raw Usage**: [5:8]: The number of 64 GByte increments read by the host
245	100	Percent Drive Life Used	Raw Usage	The percent drive life used based on the percentage of over-provisioned erase blocks that are defective. This is the complement to attribute ID 177. **Normalized Range**: Best: 0 Worst: 0 **Raw Usage:** [5:8]: The percent of drive life used

7.0 Part Numbers

7.1 Part Numbering Information

Table 17: CloudSpeed Ascend Part Numbering Information

CloudSpeed Ascend Part Number	Drive Capacity	LBA Count
SDLFODAR-240G-1HA1	240 GBytes	468,862,128
SDLFODAR-480G-1HA1	480 GBytes	937,703,088
SDLFOCAR-960G-1HA1	960 GBytes	1,875,385,008

Table 18: CloudSpeed Ultra Part Numbering Information

CloudSpeed Ultra Part Number	Drive Capacity	LBA Count
SDLFODAM-200G-1HA1	200 GBytes	390,721,968
SDLFODAM-400G-1HA1	400 GBytes	781,422,768
SDLFOCAM-800G-1HA1	800 GBytes	1,562,824,368