Intel® Solid-State Drive 525 Series

Product Specification

- Capacity: 30/60/120/180/240 GB
- Components:
  - Intel® 25nm NAND Flash Memory
  - Multi-Level Cell (MLC)
- Form Factor: mSATA full size
- Thickness: 3.7 mm
- Weight: <10 grams
- SATA 6Gb/s Bandwidth Performance[1] (Iometer* Queue Depth 32)
  - Sustained Sequential Read: up to 550 MB/s
  - Sustained Sequential Write: up to 520 MB/s
- Read and Write IOPS[1] (Iometer Queue Depth 32)
  - Random 4 KB Reads: Up to 50,000 IOPS
  - Random 4 KB Writes: Up to 80,000 IOPS[2]
- Latency (average sequential)
  - Read: 80 µs (TYP)
  - Write: 85 µs (TYP)
- Data Compression
- AES 128-bit Encryption
- End-to-end Data Protection
- Compatibility
  - Intel® SSD Toolbox with Intel® SSD Optimizer
  - Intel® Data Migration Software
  - Intel® Rapid Storage Technology
  - SATA Revision 3.0
  - ACS-2
  - SSD-enhanced SMART ATA feature set
  - Native Command Queuing (NCQ) command set

  Data Set Management Command Trim attribute
- Power Management
  - 3.3 V SATA Supply Rail
  - SATA Link Power Management (LPM)
- Power
  - Active (MobileMark* 2007 Workload): 300 mW (TYP)
  - Idle: 250 mW (TYP)
- Temperature
  - Operating: 0° C to 70° C
  - Non-Operating: -55° C to 95° C
- Reliability
  - Uncorrectable Bit Error Rate (UBER): <1 sector per 10^{16} bits read
  - Mean Time Between Failure (MTBF): 1,200,000 hours
  - Shock (operating and non-operating): 1,000 G/0.5 msec
- Vibration
  - Operating: 2.17 G_{RMS} (5-700 Hz)
  - Non-operating: 3.13 G_{RMS} (5-800 Hz)
- Certifications and Declarations:
  - UL*
  - CE*
  - C-Tick*
  - BSMI*
  - KCC*
  - Microsoft* WHCK
  - VCCI*
  - SATA-IO*
- Product Ecological Compliance

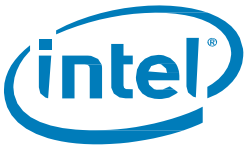
  RoHS*

1. Performance values vary by capacity.
2. Random 4 KB writes measured using out-of-box SSD.

Order Number: 328354-001US
December 2012

Ordering Information

Contact your local Intel sales representative for ordering information.



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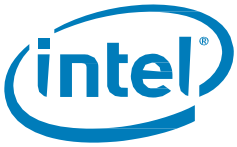


1.0 Overview

This document describes the specifications and capabilities of the Intel® Solid-State Drive 525 Series (Intel® SSD 525 Series)[1].

The Intel SSD 525 Series delivers small form-factor storage and leading performance for Serial Advanced Technology Attachment (SATA)-based computers in capacities ranging from 30GB to 240GB.

By combining Intel's high quality 25nm NAND flash memory technology with SATA 6Gb/s interface support, the Intel SSD 525 Series delivers sequential read speeds of up to 550 MB/s and sequential write speeds of up to 520 MB/s.

The case-less mSATA (mini-SATA) design has a significantly smaller footprint than a 2.5-inch hard disk drive (HDD), and enables fast read/write access times and a significant I/O and throughput performance improvement as compared to HDDs. This design makes it ideal for new and innovative small form factor computing platforms that have size and weight requirements that traditional 2.5-inch or 1.8-inch HDDs cannot meet; such as, netbooks, thin-and-light systems, mini- and sub-notebooks, all-in-one computers, and embedded platforms.

As compared to standard SATA HDDs, Intel SSD 525 Series offers these key features:

- High I/O and throughput performance
- Low power
- Increased system responsiveness
- High reliability
- Enhanced ruggedness
- Small form-factor
- Minimum weight

The Intel SSD 525 Series also offers additional key features such as:

- Advanced Encryption Standard (AES) 128-bit Encryption

  AES 128-bit encryption is an industry standard in data security, providing a hardware-based mechanism for encryption and decryption of user data. Utilizing a 128-bit encryption key, AES encryption—when combined with an ATA drive password—helps protect user data.
- End-to-End Data Protection

  End-to-end data protection helps protect data from being corrupted across the data path by using cyclic redundancy check (CRC), parity, and error correction code (ECC) checks in the data path from the host interface to the NAND, and back.
- Data Compression

  Data compression helps improve performance and endurance by automatically compressing information sent to the SSD so that less data has to be processed and stored on the NAND. The amount of data that can be compressed depends on the type of data.

Note: 1. The Intel SSD 525 Series is currently not validated for data center usage.

2.0 Product Specifications

2.1 Capacity

Table 1. User Addressable Sectors

Intel SSD 525 Series	Unformatted Capacity (Total User Addressable Sectors in LBA Mode)
30 GB	58,626,288
60 GB	117,231,408
120 GB	234,441,648
180 GB	351,651,888
240 GB	468,862,128

Note: 1 GB = 1,000,000,000 bytes; 1 sector = 512 bytes.
LBA count shown represents total user storage capacity and will remain the same throughout the life of the drive.
The total usable capacity of the SSD may be less than the total physical capacity because a small portion of the capacity is used for NAND flash management and maintenance purposes.

2.2 Performance

The data compression engine in the Intel SSD 525 Series controller optimizes performance based on the data pattern of the workload.

This section provides both compressible and incompressible Input/Output Operations Per Second (IOPS) and sustained sequential read and write bandwidth specifications.

Table 2. Compressible Performance

Specification	Unit	Intel SSD 525 Series				
		30 GB	60 GB	120 GB	180 GB	240 GB
Random 4 KB Read (up to)	IOPS	5,000	15,000	25,000	50,000	50,000
Random 4 KB Write (up to)[1]	IOPS	80,000	80,000	80,000	80,000	80,000
Random 4 KB Write (TYP)[2]	IOPS	10,000	23,000	40,000	60,000	60,000
Sequential Read (up to)[3] SATA 6Gb/s SATA 3Gb/s	MB/s	 500 280	 550 280	 550 280	 550 280	 550 280
Sequential Write (up to)[3] SATA 6Gb/s SATA 3Gb/s	MB/s	 275 240	 475 245	 500 260	 520 260	 520 260

Notes:
1. Random 4 KB write performance measured using out-of-box SSD.
2. Performance measured using Iometer* with Queue Depth 32. Measurements are performed on 8 GB of Logical Block Address (LBA) range on a full SSD.
3. Performance measured using Iometer with Queue Depth 32.

Table 3. Incompressible Performance

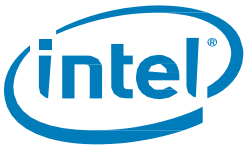
Specification	Unit	Intel SSD 525 Series				
		30 GB	60 GB	120 GB	180 GB	240 GB
Random 4 KB Read (up to) [1]	IOPS	7,000	12,000	24,000	46,000	46,000
Random 4 KB Write (up to) [1]	IOPS	2,500	6,900	13,000	13,000	16,500
Sequential Read (up to) [1]	MB/s	200	430	550	550	550
Sequential Write (up to) [1]	MB/s	40	80	150	170	235

Notes:
1. Performance measured using Iometer with Queue Depth 32. Measurements are performed on 8 GB of Logical Block Address (LBA) range.

Table 4. Latency

Specification	Intel SSD 525 Series
Latency[1]	
Read	80 µs (TYP)
Write	85 µs (TYP)
Power On To Ready[2]	2 s (TYP)

Notes:
1. Based on sequential 4 KB using Iometer with Queue Depth 1 workload with compressible (non-random) data pattern. Write Cache Enabled.
2. Power On To Ready time assumes proper shutdown.



2.3 Electrical Characteristics

Table 5. Operating Voltage and Power Consumption

Electrical Characteristics	Value
Operating Voltage for 3.3 V (±5%)	
Min	3.14 V
Max	3.47 V
Power Consumption (TYP)	
Active[1]	300 mW
Idle[2]	250 mW

Notes:
1. Active power measured during execution of MobileMark* 2007 with SATA Link Power Management (LPM) enabled.
2. Idle power defined as SSD at idle with SATA Link Power Management (LPM) enabled.

2.4 Environmental Conditions

Table 6. Temperature, Shock, Vibration

Temperature	Range
Module Temperature	
Operating[1]	0 – 70 °C
Non-operating	-55 – 95 °C
Temperature Gradient[2]	
Operating	30 (TYP) °C/hr
Non-operating	30 (TYP) °C/hr
Humidity	
Operating	5 – 95 %
Non-operating	5 – 95 %
Shock and Vibration	**Range**
Shock[3]	
Operating	1,000 G (Max) at 0.5 msec
Non-operating	1,000 G (Max) at 0.5 msec
Vibration[4]	
Operating	2.17 G_{RMS} (5-700 Hz) Max
Non-operating	3.13 G_{RMS} (5-800 Hz) Max

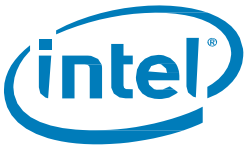
Notes:
1. As measured by temperature sensor, SMART Attribute BEh.
2. Temperature gradient measured without condensation.
3. Shock specifications assume that one side of SSD is inserted into SATA connector and the other side is secured by screw. Both connector and screw are securely mounted on a fixture that is firmly attached on a shock table. The shock stimulus is applied in X, Y and Z axis respectively. Shock specification is measured using peak acceleration and pulse width value.
4. Vibration specifications assume that one side of SSD is inserted into SATA connector and the other side is secured by screw. Both connector and screw are securely mounted on a fixture that is firmly attached on vibration table. The vibration stimulus is applied in X, Y and Z axis respectively Vibration specification is measured using G Root mean Squared (GRMS) value.

2.5 Product Regulatory Compliance

The Intel SSD 525 Series meets or exceeds the regulatory or certification requirements in Product Regulatory Compliance Specifications

Table 7. Product Regulatory Compliance Specifications

Title	Description	Region for which conformity declared
TITLE 47-Telecommunication CHAPTER I— FEDERAL COMMUNICATIONS COMMISSION PART 15 — RADIO FREQUENCY DEVICES ICES-003, Issue 4 Interference-Causing Equipment Standard Digital Apparatus	FCC Part 15B Class B CAN/CSA-CEI/IEC CISPR 22:02. This is CISPR 22:1997 with Canadian modifications.	USA Canada
IEC 555024 Information Technology Equipment — Immunity characteristics — Limits and methods of measurement CISPR 24:2010	EN-55024: 1998 and its amendments	European Union
EN-55022 Information technology equipment — Radio disturbance characteristics — Limits and methods of measurement CISPR 22:2008 (Modified)	EN-55022: 2006 and its amendments	European Union
EN-60950-1 2nd Edition	Information Technology Equipment — Safety — Part 1: General Requirements	USA / Canada
UL/CSA 60950-1 2nd Edition	Information Technology Equipment — Safety — Part 1: General Requirements	USA / Canada



2.6 Reliability

The Intel SSD 525 Series meets or exceeds SSD endurance and data retention requirements as specified in the JESD218 specification.

Reliability specifications are listed in Reliability Specifications.

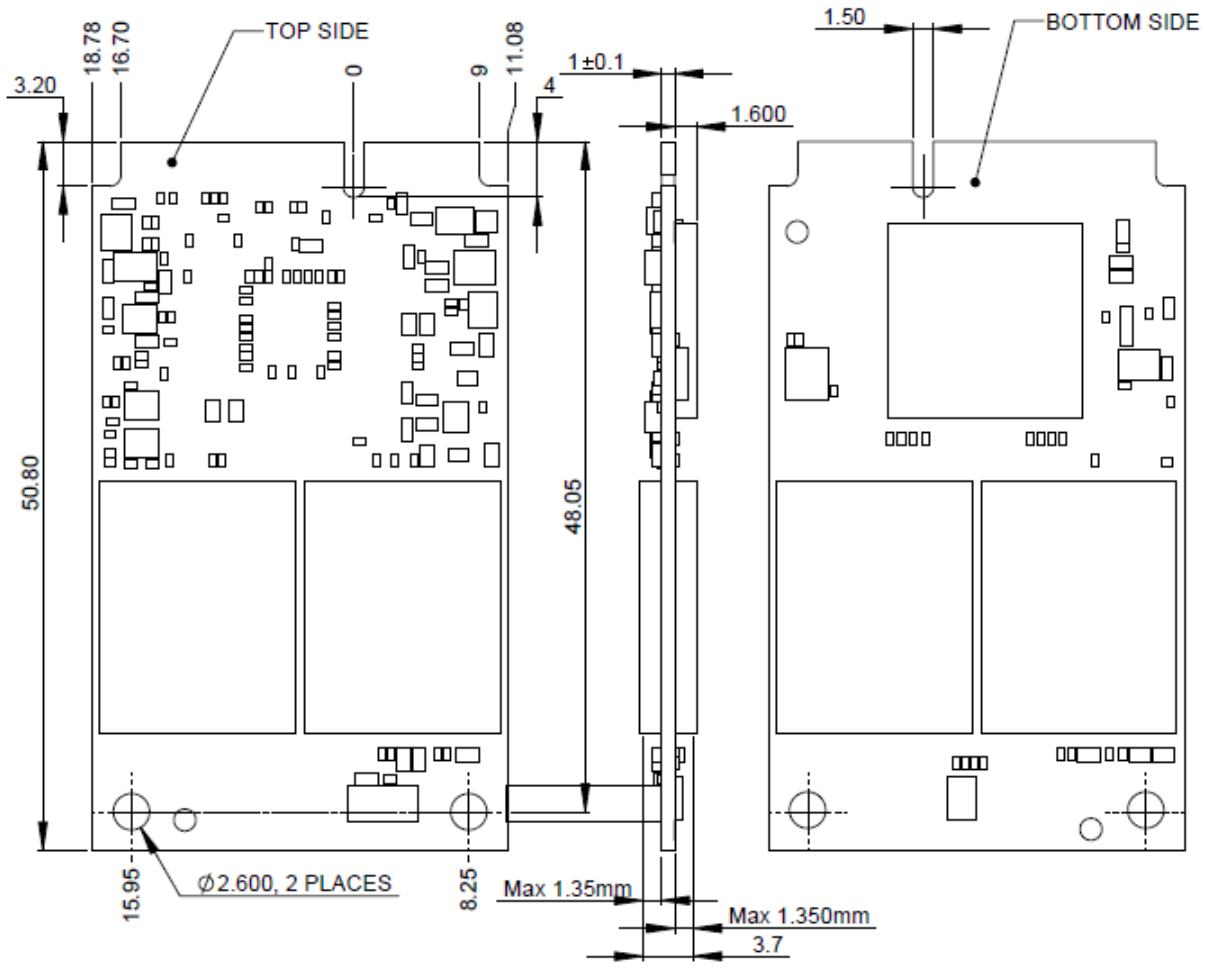
Table 8. Reliability Specifications

Parameter	Value	
Uncorrectable Bit Error Rate (UBER)	< 1 sector per 10^{16} bits read	
Uncorrectable bit error rate will not exceed one sector in the specified number of bits read. In the unlikely event of a nonrecoverable read error, the SSD will report it as a read failure to the host; the sector in error is considered corrupt and is not returned to the host.		
Mean Time Between Failures (MTBF)	1,200,000 hours	
Mean Time Between Failures is estimated based on Telcordia* methodology and demonstrated through Reliability Demonstration Test (RDT).		
Minimum Useful Life/Endurance Rating	30 GB: 3 years	Other Capacities: 5 years
Minimum useful life under typical client workloads with up to 20 GB of host writes per day.		
Insertion Cycles	250 insertion/removal cycles	
Maximum insertion/removal cycles on mSATA/power cable.		

3.0 Mechanical Information

This figure shows the physical package information for the mSATA full size Intel SSD 525 Series. All dimensions are in millimeters.

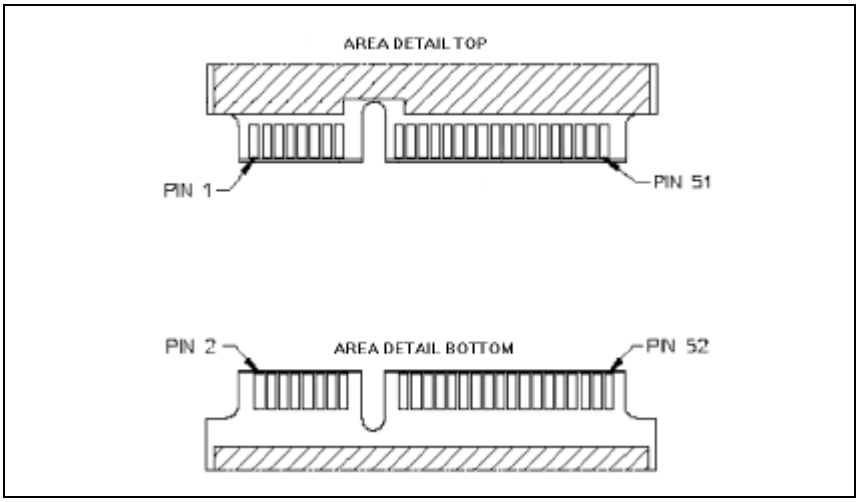
Figure 1. Dimensions for Intel SSD 525 Series



4.0 Pin and Signal Descriptions

4.1 Pin Locations

Figure 3. Layout of Signal and Power Segment Pins



4.2 Signal Descriptions

Table 9. Serial ATA Power Pin Definitions

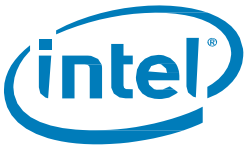
Pin[1]	Function	Definition
P1	Reserved	No Connect
P2	+3.3 V	3.3 V Source
P3	Reserved	No Connect
P4	GND	Return Current Path
P5	Reserved	No Connect
P6[1]	+1.5 V	1.5 V Source
P7	Reserved	No Connect
P8	Reserved	No Connect
P9	GND	Return Current Path
P10	Reserved	No Connect
P11	Reserved	No Connect
P12	Reserved	No Connect
P13	Reserved	No Connect
P14	Reserved	No Connect
P15	GND	Return Current Path
P16	Reserved	No Connect
P17	Reserved	No Connect
P18	GND	Return Current Path
P19	Reserved	No Connect

Table 9. Serial ATA Power Pin Definitions

Pin[1]	Function	Definition
P20	Reserved	No Connect
P21	GND	Return Current Path
P22	Reserved	No Connect
P23	+B	Host Receiver Differential Signal Pair (This is an output of the SSD)
P24	+3.3 V	3.3 V Source
P25	-B	Host Receiver Differential Signal Pair (This is an output of the SSD)
P26	GND	Return Current Path
P27	GND	Return Current Path
P28[1]	+1.5 V	1.5 V Source
P29	GND	Return Current Path
P30[2]	Two Wire Interface	Two Wire Interface Clock
P31	-A	Host Transmitter Differential Signal Pair (This is an input of the SSD)
P32[2]	Two Wire Interface	Two Wire Interface Data
P33	+A	Host Transmitter Differential Signal Pair (This is an input of the SSD)
P34	GND	Return Current Path
P35	GND	Return Current Path
P36	Reserved	No Connect
P37	GND	Return Current Path
P38	Reserved	No Connect
P39	+3.3 V	3.3 V Source
P40	GND	Return Current Path
P41	+3.3 V	3.3 V Source
P42	Reserved	No Connect
P43	Device Type	No Connect
P44	Reserved	No Connect
P45[3]	Vendor	Vendor Specific / Manufacturing Pin
P46	Reserved	No Connect
P47[3]	Vendor	Vendor Specific / Manufacturing Pin
P48[1]	+1.5 V	1.5 V Source
P49	DA/DSS	Device Activity Signal / Disable Staggered Spin-up
P50	GND	Return Current Path
P51[4]	Presence Detection	Shall be pulled to GND by device
P52	+3.3 V	3.3 V Source

Notes:

1. 1.5 V rail is not used on the Intel SSD 525 Series. No connect on the host side. Pin 6, 28, and 48 shall be unconnected on the device side to avoid conflicts with wireless coexistence pins as specified in PCI Express Mini Card Specification.
2. Pins 30 and 32 are intended for use as a two-wire interface to read a memory device to determine device information (an example of this would be for use as SMB bus pins). These pins are not designed to be active in conjunction with the SATA signal differential pairs. Not used on the Intel SSD 525 Series. No connect on the host side.
3. Vendor-specific pins are not used in the Intel SSD 525 Series. No connect on the host side.
4. Presence detection pin indicates presence of an mSATA device.



5.0 Supported Command Sets

The Intel SSD 525 Series supports all mandatory Advanced Technology Attachment (ATA) and Serial ATA (SATA) commands defined in the ACS-2 and SATA Revision 3.0 specifications. The mandatory and optional commands are defined in this section.

5.1 ATA General Feature Command Set

General Feature command set (non-PACKET), which consists of:

- EXECUTE DEVICE DIAGNOSTIC
- FLUSH CACHE
- IDENTIFY DEVICE

Note: See the Appendix for details on the sector data returned after issuing an IDENTIFY DEVICE command.

- READ DMA
- READ SECTOR(S)
- READ VERIFY SECTOR(S)
- SEEK
- SET FEATURES
- WRITE DMA
- WRITE SECTOR(S)
- READ MULTIPLE
- SET MULTIPLE MODE
- WRITE MULTIPLE

The Intel SSD 525 Series also supports the following optional commands:

- READ BUFFFER
- WRITE BUFFER
- NOP
- DOWNLOAD MICROCODE

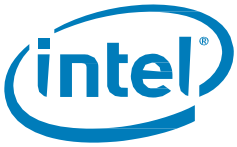
5.2 Power Management

The Intel SSD 525 Series supports several power management feature sets as defined by the ATA specification: general Power Management feature set, Advanced Power Management feature set, and Power-Up In Standby (PUIS) feature set.

The Advanced Power Management and PUIS features can be enabled or disabled using the SET FEATURES command.

The Power Management feature set includes the following commands:

- CHECK POWER MODE
- IDLE
- IDLE IMMEDIATE
- SLEEP
- STANDBY
- STANDBY IMMEDIATE



5.3 Security Mode Feature Set

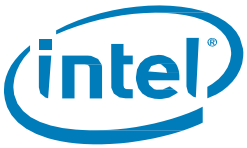
The Intel SSD 525 Series supports the Security Mode command set, which consists of:

- SECURITY SET PASSWORD
- SECURITY UNLOCK
- SECURITY ERASE PREPARE
- SECURITY ERASE UNIT
- SECURITY FREEZE LOCK
- SECURITY DISABLE PASSWORD

5.4 SMART Command Set

The Intel SSD 525 Series supports the SMART command set, which consists of:

- SMART READ DATA
- SMART READ ATTRIBUTE THRESHOLDS
- SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE
- SMART SAVE ATTRIBUTE VALUES
- SMART EXECUTE OFF-LINE IMMEDIATE
- SMART READ LOG SECTOR
- SMART WRITE LOG SECTOR
- SMART ENABLE OPERATIONS
- SMART DISABLE OPERATIONS
- SMART RETURN STATUS



5.4.1 SMART Attributes

Table 10 lists the SMART attributes supported by the Intel SSD 525 Series; Table 11 lists the corresponding status flags and threshold settings.

Table 10. SMART Attributes

ID	Attribute	Status Flags[1]						Threshold
		SP	EC	ER	PE	OC	PW	
05h	Re-allocated Sector Count The raw value of this attribute shows the number of retired blocks since leaving the factory (grown defect count).	1	1	0	0	1	0	0 (none)
09h	Power-On Hours Count The raw value reports two values: the first 4 bytes report the cumulative number of power-on hours over the life of the device, the remaining bytes report the number of milliseconds since the last hour increment. The On/Off status of the Device Initiated Power Management (DIPM) feature will affect the number of hours reported. If DIPM is turned On, the recorded value for power-on hours does not include the time that the device is in a "slumber" state. If DIPM is turned Off, the recorded value for power-on hours should match the clock time, as all three device states are counted: active, idle and slumber.	1	1	0	0	1	0	0 (none)
0Ch	Power Cycle Count The raw value of this attribute reports the cumulative number of power cycle events over the life of the device.	1	1	0	0	1	0	0 (none)
AAh	Available Reserved Space	1	1	0	0	1	1	10
ABh	Program Fail Count The raw value of this attribute shows total count of program fails and the normalized value, beginning at 100, shows the percent remaining of allowable program fails.	1	1	0	0	1	0	0 (none)
ACh	Erase Fail Count The raw value of this attribute shows total count of erase fails and the normalized value, beginning at 100, shows the percent remaining of allowable erase fails.	1	1	0	0	1	0	0 (none)
AEh	Unexpected Power Loss The raw value of this attribute reports the cumulative number of unsafe (unclean) shutdown events over the life of the device. An unsafe shutdown occurs whenever the device is powered off without STANDBY IMMEDIATE being the last command	1	1	0	0	1	0	0 (none)
B7h	SATA Downshift Count The count of the number of times SATA interface selected lower signaling rate due to error.	1	1	0	0	1	0	10
B8h	End-to-End Error Detection Count Reports number of errors encountered during end-to-end error detection within the SSD data path.	1	1	0	0	1	1	90

Table 10. SMART Attributes

ID	Attribute	Status Flags[1]						Threshold
		SP	EC	ER	PE	OC	PW	
BBh	Uncorrectable Error Count The raw value shows the count of errors that could not be recovered using Error Correction Code (ECC).	1	1	0	0	1	0	0 (none)
BEh	Temperature Reports real-time temperature of drive as measured by temperature sensor on drive PCB. The normalized value reports the current temperature value. The raw value shows current, lifetime highest and lifetime lowest temperatures. Byte 1:0 = current temp Celsius; Byte 3:2 = lifetime highest temp Celsius; Byte 5:4 = lifetime lowest temp Celsius.	1	1	0	0	1	0	0(none)
C0h	Power-Off Retract Count (Unsafe Shutdown Count) The raw value of this attribute reports the cumulative number of unsafe (unclean) shutdown events over the life of the device. An unsafe shutdown occurs whenever the device is powered off without STANDBY IMMEDIATE being the last command.	1	1	0	0	1	0	0 (none)
C7h	CRC Error Count The total number of encountered SATA interface cyclic redundancy check (CRC) errors.	1	1	0	0	1	0	0 (none)
E1h	Host Writes The raw value of this attribute reports the total number of sectors written by the host system. The raw value is increased by 1 for every 65,536 sectors (32MB) written by the host.	1	1	0	0	1	0	0 (none)
E2h	Timed Workload Media Wear Measures the wear seen by the SSD (since reset of the workload timer, attribute E4h), as a percentage of the maximum rated cycles.	1	1	0	0	1	0	0 (none)
E3h	Timed Workload Host Read/Write Ratio Shows the percentage of I/O operations that are read operations (since reset of the workload timer, attribute E4h).	1	1	0	0	1	0	0 (none)
E4h	Timed Workload Timer Measures the elapsed time (number of minutes since starting this workload timer).	1	1	0	0	1	0	0 (none)
E8h	Available Reserved Space This attribute reports the number of reserve blocks remaining. The normalized value begins at 100 (64h), which corresponds to 100 percent availability of the reserved space. The threshold value for this attribute is 10 percent availability.	1	1	0	0	1	1	10

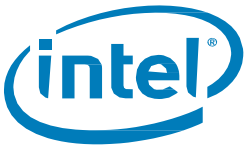


Table 10. SMART Attributes

ID	Attribute	Status Flags[1]						Threshold
		SP	EC	ER	PE	OC	PW	
E9h	Media Wearout Indicator This attribute reports the number of cycles the NAND media has undergone. The normalized value declines linearly from 100 to 1 as the average erase cycle count increases from 0 to the maximum rated cycles. Once the normalized value reaches 1, the number will not decrease, although it is likely that significant additional wear can be put on the device.	1	1	0	0	1	0	0 (none)
F1h	Total LBAs Written The raw value of this attribute reports the total number of sectors written by the host system. The raw value is increased by 1 for every 65,536 sectors (32MB) written by the host.	1	1	0	0	1	0	0 (none)
F2h	Total LBAs Read The raw value of this attribute reports the total number of sectors read by the host system. The raw value is increased by 1 for every 65,536 sectors (32MB) read by the host.	1	1	0	0	1	0	0 (none)
F9h	Total NAND Writes Raw value reports the number of writes to NAND in 1 GB increments.	1	1	0	0	1	0	0 (none)

Table 11 defines the SMART Attribute status flags.

Table 11. SMART Attribute Status Flags

Status Flag	Description	Value = 0	Value = 1
SP	Self-preserving attribute	Not a self-preserving attribute	Self-preserving attribute
EC	Event count attribute	Not an event count attribute	Event count attribute
ER	Error rate attribute	Not an error rate attribute	Error rate attribute
PE	Performance attribute	Not a performance attribute	Performance attribute
OC	Online collection attribute	Collected only during offline activity	Collected during both offline and online activity
PW	Pre-fail warranty attribute	Advisory	Pre-fail

5.4.2 SMART Logs

The Intel SSD 525 Series implements the following Log Addresses: 00h, 02h, 03h, 06h, and 07h.

The Intel SSD 525 Series implements host vendor specific logs (addresses 80h-9Fh) as read and write scratchpads, where the default value is zero (0). Intel SSD 525 Series does not write any specific values to these logs unless directed by the host through the appropriate commands.

The Intel SSD 525 Series also implements a device vendor specific log at address A9h as a read-only log area with a default value of zero (0).

5.5 Device Statistics

In addition to the SMART attribute structure, statistics pertaining to the operation and health of the Intel SSD 525 Series can be reported to the host on request through the Device Statistics log as defined in the ATA specification.

The Device Statistics log is a read-only GPL/SMART log located at read log address 0x04 and is accessible using READ LOG EXT, READ LOG DMA EXT or SMART READ LOG commands.

Table 12 lists the Device Statistics supported by the Intel SSD 525 Series.

Table 12. Device Statistics Log

Page	Offset	Description	Equivalent SMART attribute if applicable
0x00	-	List of Supported Pages	-
0x01 - General Statistics	0x08	Power Cycle Count	0Ch
	0x10	Power-On Hours	09h
	0x18	Logical Sectors Written	E1h
	0x20	Num Write Commands - incremented by one for every host write command	-
	0x28	Logical Sectors Read	F2h
	0x30	Num Read Commands - incremented by one for every host write command	-
0x04 - General Errors Statistics	0x08	Num Reported Uncorrectable Errors	BBh
	0x10	Num Resets Between Command Acceptance and Completion	-
0x06 - Transport Statistics	0x08	Num Hardware Resets	-
	0x10	Num ASR Events	-
	0x18	Num Interface CRC Errors	-
0x07 - Solid State Device Statistics	0x08	Percentage Used Endurance Indicator	E9h This statistic counts up from 0 rather than down from 100, and may go beyond 100 for drives that exceed their expected lifetime.

5.6 SMART Command Transport (SCT)

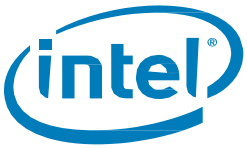
With SMART Command Transport (SCT), a host can send commands and data to an SSD and receive status and data from an SSD using standard write/read commands to manipulate two SMART Logs:

- Log Address E0h ("SCT Command/Status") — used to send commands and retrieve status
- Log Address E1h ("SCT Data Transfer") — used to transport data

5.7 Data Set Management Command Set

The Intel SSD 525 Series supports the Data Set Management command set Trim attribute, which consists of:

- DATA SET MANAGEMENT



5.8 Host Protected Area Command Set

The Intel SSD 525 Series supports the Host Protected Area command set, which consists of:

- READ NATIVE MAX ADDRESS
- SET MAX ADDRESS
- READ NATIVE MAX ADDRESS EXT
- SET MAX ADDRESS EXT

5.9 48-Bit Address Command Set

The Intel SSD 525 Series supports the 48-bit Address command set, which consists of:

- FLUSH CACHE EXT
- READ DMA EXT
- READ NATIVE MAX ADDRESS
- READ NATIVE MAX ADDRESS EXT
- READ SECTOR(S) EXT
- READ VERIFY SECTOR(S) EXT
- SET MAX ADDRESS EXT
- WRITE DMA EXT
- WRITE MULTIPLE EXT
- WRITE SECTOR(S) EXT

5.10 General Purpose Log Command Set

The Intel SSD 525 Series supports the General Purpose Log command set, which consists of:

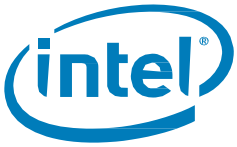
- READ LOG EXT
- WRITE LOG EXT
- READ LOG DMA EXT
- WRITE LOG DMA EXT

5.11 Native Command Queuing

The Intel SSD 525 Series supports the Native Command Queuing (NCQ) command set, which includes:

- READ FPDMA QUEUED
- WRITE FPDMA QUEUED

Note: With a maximum queue depth equal to 32.

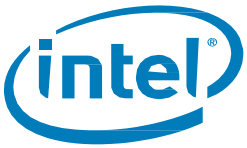


5.12 Software Settings Preservation

The Intel SSD 525 Series supports the SET FEATURES parameter to enable/disable the preservation of software settings.

5.13 SATA Link Power Management (LPM)

The Intel SSD 525 Series supports the SET FEATURES parameter to enable Device Initiated Power Management (DIPM). The SSD also supports Host Initiated Power Management (HIPM).



6.0 Certifications and Declarations

Table 13 describes the Device Certifications supported by the Intel SSD 525 Series.

Table 13. Device Certifications and Declarations

Certification	Description
CE Compliant	Low Voltage DIRECTIVE 2006/95/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 December 2006, and EMC Directive 2004/108/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 December 2004. Per EN 50581:2012 – Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances.
UL Certified	Certified Underwriters Laboratories, Inc. Bi-National Component Recognition; UL 60950-1, 2nd Edition, 2007-03-27 (Information Technology Equipment - Safety - Part 1: General Requirements) CSA C22.2 No. 60950-1-07, 2nd Edition, 2007-03 (Information Technology Equipment - Safety - Part 1: General Requirements)
C-Tick Compliant	Compliance with the Australia/New Zealand Standard AS/NZS3548 and Electromagnetic Compatibility (EMC) Framework requirements of the Australian Communication Authority (ACA).
BSMI Compliant	Compliance to the Taiwan EMC standard CNS 13438: Information technology equipment - Radio disturbance Characteristics - limits and methods of measurement, as amended on June 1, 2006, is harmonized with CISPR 22: 2005.04.
KCC	Compliance with paragraph 1 of Article 11 of the Electromagnetic Compatibility Control Regulation and meets the Electromagnetic Compatibility (EMC) Framework requirements of the Radio Research Laboratory (RRL) Ministry of Information and Communication Republic of Korea.
Microsoft WHCK	Microsoft Windows Hardware Certification Kit
RoHS Compliant	Restriction of Hazardous Substance Directive
VCCI	Voluntary Control Council for Interface to cope with disturbance problems caused by personal computers or facsimile.
SATA-IO	Indicates certified logo program from Serial ATA International Organization.
Low Halogen	Applies only to brominated and chlorinated flame retardants (BFRs/CFRs) and PVC in the final product. Intel components as well as purchased components on the finished assembly meet JS-709 requirements, and the PCB/substrate meet IEC 61249-2-21 requirements. The replacement of halogenated flame retardants and/or PVC may not be better for the environment.

7.0 References

Table 14 identifies the standards information referenced in this document.

Table 14. Standards References

Date or Rev. #	Title	Location
Sept 2010	Solid-State Drive (SSD) Requirements and Endurance Test Method (JESD218)	http://www.jedec.org/standards-documents/docs/jesd218/
Dec 2008	VCCI	http://www.vcci.jp/vcci_e/
June 2009	RoHS	http://qdms.intel.com/ Click *Search MDDS Database* and search for material description datasheet
August 2009	ACS-2 Specification	http://www.t13.org/
June 2009	Serial ATA Revision 3.0	http://www.sata-io.org/
Oct 2010	JEDEC Solid-State Product Outline – mSATA SSD Assembly	http://www.jedec.org/
July 2011	Serial ATA Revision 3.1 (mSATA definition)	http://www.sata-io.org/
	Compliance with EN 55022:1998 Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement CISPR 22:1997 (Modified)	http://www.iec.ch/

8.0 Terms and Acronyms

Table 15 defines the terms and acronyms used in this document.

Table 15. Glossary of Terms and Acronyms

Term	Definition
ATA	Advanced Technology Attachment
DAS	Device Activity Signal
DIPM	Device Initiated Power Management
DMA	Direct Memory Access
EXT	Extended
FPDMA	First Party Direct Memory Access
GB	Gigabyte (1,000,000,000 bytes) Note: The total usable capacity of the SSD may be less than the total physical capacity because a small portion of the capacity is used for NAND flash management and maintenance purposes.
HDD	Hard Disk Drive

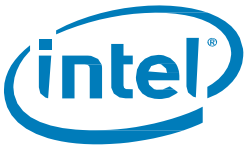


Table 15. Glossary of Terms and Acronyms

Term	Definition
HIPM	Host Initiated Power Management
I/O	Input/Output
IOPS	Input/Output Operations Per Second
KB	Kilobyte (1,024 bytes)
LBA	Logical Block Address
LPM	Link Power Management
MB	Megabyte (1,000,000 bytes)
MLC	Multi-level Cell
MTBF	Mean Time Between Failures
NCQ	Native Command Queuing
NOP	No Operation
PIO	Programmed Input/Output
RDT	Reliability Demonstration Test
RMS	Root Mean Squared
SATA	Serial Advanced Technology Attachment
SMART	Self-Monitoring, Analysis and Reporting Technology
SSD	Solid-State Drive
TYP	Typical
UBER	Uncorrectable Bit Error Rate

9.0 Revision History

Date	Revision	Description
December 2012	001	Initial release.

Appendix: IDENTIFY DEVICE Command Data

Table 16 details the sector data returned after issuing an IDENTIFY DEVICE command.

Table 16. Returned Sector Data

Word	F = Fixed V = Variable X = Both	Default Value	Description
0	F	0040h	General configuration bit-significant information
1	X	3FFFh	Obsolete - Number of logical cylinders (16,383)
2	V	C837h	Specific configuration
3	X	0010h	Obsolete - Number of logical heads (16)
4-5	X	0h	Retired
6	X	003Fh	Obsolete - Number of logical sectors per logical track (63)
7-8	V	0h	Reserved for assignment by the CompactFlash* Association (CFA)
9	X	0h	Retired
10-19	F	varies	Serial number (20 ASCII characters)
20-21	X	0h	Retired
22	X	0h	Obsolete
23-26	F	varies	Firmware revision (8 ASCII characters)
27-46	F	varies	Model number (Intel® Solid-State Drive)
47	F	8010h	7:0—Maximum number of sectors transferred per interrupt on multiple commands
48	F	4000h	Reserved
49	F	2F00h	Capabilities
50	F	4000h	Capabilities
51-52	X	0h	Obsolete
53	F	0007h	Words 88 and 70:64 valid
54	X	3FFFh	Obsolete - Number of logical cylinders (16,383)
55	X	0010h	Obsolete - Number of logical heads (16)
56	X	003Fh	Obsolete - Number of logical sectors per logical track (63)
57-58	X	00FBFC10h	Obsolete

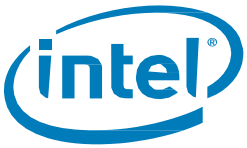


Table 16. Returned Sector Data

Word	F = Fixed V = Variable X = Both	Default Value	Description
59	V	0110h	Number of sectors transferred per interrupt on multiple commands
60-61	F	varies	Total number of user-addressable sectors
62	X	0h	Obsolete
63	F	0007h	Multi-word DMA modes supported/selected
64	F	0003h	PIO modes supported
65	F	0078h	Minimum multiword DMA transfer cycle time per word
66	F	0078h	Manufacturer's recommended multiword DMA transfer cycle time
67	F	0078h	Minimum PIO transfer cycle time without flow control
68	F	0078h	Minimum PIO transfer cycle time with IORDY flow control
69	F	4010h	Additional Supported
70	F	0h	Reserved
71-74	F	0h	Reserved for IDENTIFY PACKET DEVICE command
75	F	001Fh	Queue depth
76	F	070Eh	Serial ATA capabilities
77	F	0006h	Reserved for future Serial ATA definition
78	F	004Ch	Serial ATA features supported
79	V	0040h	Serial ATA features enabled
80	F	03FCh	Major version number
81	F	FFFFh	Minor version number
82	F	746Bh	Command set supported
83	F	7429h	Command sets supported
84	F	6163h	Command set/feature supported extension
85	V	7469h	Command set/feature enabled
86	V	B409h	Command set/feature enabled
87	V	6163h	Command set/feature default
88	V	207Fh	Ultra DMA Modes
89	F	0002h	Time required for security erase unit completion

Table 16. Returned Sector Data

Word	F = Fixed V = Variable X = Both	Default Value	Description
90	F	0001h	Time required for enhanced security erase completion
91	V	00FEh	Current advanced power management value
92	V	FFFEh	Master Password Revision Code
93	F	0h	Hardware reset result: the contents of bits (12:0) of this word shall change only during the execution of a hardware reset
94	V	0h	Vendor's recommended and actual acoustic management value
95	F	0h	Stream minimum request size
96	V	0h	Streaming transfer time - DMA
97	V	0h	Streaming access latency - DMA and PIO
98-99	F	0h	Streaming performance granularity
100-103	V	varies	Maximum user LBA for 48-bit address feature set
104	V	0h	Streaming transfer time - PIO
105	F	0001h	Reserved
106	F	4000h	Physical sector size / logical sector size
107	F	0h	Inter-seek delay for ISO-7779 acoustic testing in microseconds
108-111	F	varies	Unique ID
112-115	F	0h	Reserved for world wide name extension to 128 bits
116	V	0h	Reserved for technical report
117-118	F	0h	Words per logical sector
119	F	401Ch	Supported settings
120	F	401Ch	Command set/feature enabled/supported
121-126	F	0h	Reserved
127	F	0h	Removable Media Status Notification feature set support
128	V	0021h	Security status
129-159	X	varies	Vendor-specific
160	F	0h	CompactFlash Association (CFA) power mode 1
161-168	X	0h	Reserved for assignment by the CFA
169	X	0001h	Data set management Trim attribute support

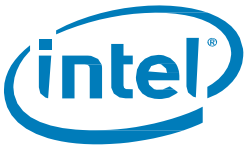


Table 16. Returned Sector Data

Word	F = Fixed V = Variable X = Both	Default Value	Description
170-173	F	0h	Additional Product Identifier
174-175	F	0h	Reserved
176-205	V	0h	Current media serial number
206	X	0021h	SCT Command Transport
207-208	X	0h	Reserved
209	X	4000h	Alignment of logical blocks within a physical block
210-211	X	0h	Write-Read-Verify Sector Count Mode 3 (DWord)
212-213	X	0h	Write-Read-Verify Sector Count Mode 2 (DWord)
214	X	0h	NV Cache Capabilities
215-216	X	0h	NV Cache Size in Logical Blocks (DWord)
217	X	0001h	Nominal media rotation rate
218	X	0h	Reserved
219	X	0h	NV Cache Options
220	X	0h	Write-Read-Verify feature set
221	X	0h	Reserved
222	X	103Fh	Transport major version number
223	X	0h	Transport minor version number
224-229	X	0h	Reserved
230-233	X	0h	Extended Number of User Addressable Sectors (QWord)
234	X	0002h	Minimum number of 512-byte data blocks per DOWNLOAD MICROCODE command for mode 03h
235	X	0400h	Maximum number of 512-byte data blocks per DOWNLOAD MICROCODE command for mode 03h
236-254	X	0h	Reserved
255	X	varies	Integrity word

Notes:
F = Fixed. The content of the word is fixed and does not change. For removable media devices, these values may change when media is removed or changed.
V = Variable. The state of at least one bit in a word is variable and may change depending on the state of the device or the commands executed by the device.
X = F or V. The content of the word may be fixed or variable.