

## Intel® Solid-State Drive DC S3500 Series (1.2TB and 1.6TB)

### Product Specification Addendum

- **Capacity:**
  - 1.2TB and 1.6TB
- **Components:**
  - Intel® 20nm NAND Flash Memory
  - Multi-Level Cell (MLC)
- **Form Factor:** 2.5-inch<sup>1</sup>
- **Read and Write IOPS<sup>2,3</sup> (Full LBA Range, IOMeter\* Queue Depth 32)**
  - Random 4 KB<sup>4</sup> Reads: Up to 65,000 IOPS
  - Random 4 KB Writes: Up to 15,500 IOPS
  - Random 8 KB<sup>4</sup> Reads: Up to 44,500 IOPS
  - Random 8 KB Writes: Up to 8,000 IOPS
- **Bandwidth Performance<sup>2</sup>**
  - Sustained Sequential Read: Up to 500 MB/s<sup>5</sup>
  - Sustained Sequential Write: Up to 460 MB/s<sup>5</sup>
- **Latency (average sequential)**
  - Read: 55 µs (TYP)
  - Write: 65 µs (TYP)
- **Quality of Service<sup>6,7</sup>**
  - Read/Write: 500 µs / 5 ms (99.9%)
- **AES 256-bit Encryption**
- **Compliance**
  - SATA Revision 3.0; compatible with SATA 6Gb/s, 3Gb/s and 1.5Gb/s interface rates
  - ATA8-ACS2; includes SCT (Smart Command Transport) and device statistics log support
  - Enhanced SMART ATA feature set
  - Native Command Queuing (NCQ) command set
  - Data set management Trim command
- **Compatibility**
  - Windows 7\*, Windows 8\*, Windows 8.1\*
  - Windows\* Server 2012 R2\*, Windows Server 2012\*
  - Windows\* Server 2008\* Enterprise 32/64bit SP2
  - Windows\* Server 2008\* R2 SP1
  - Windows\* Server 2003\* Enterprise 64bit SP2
  - Red Hat\* Enterprise Linux\* 5.5, 5.6, 6.1, 6.3, 7.0
  - SUSE\* Linux Enterprise Server 10\*, 11
  - SP1CentOS\* 64bit 5.7, 6.3
  - Intel® SSD Toolbox with Intel® SSD Optimizer
- **Altitude<sup>8</sup>**
  - Operating: -1,000 to 10,000 ft
  - Operating<sup>9</sup>: -10,000 to 15,000 ft
  - Non-operating: -1,000 to 40,000 ft
- **Product Ecological Compliance**
  - RoHS\*
- **Power Management**
  - 2.5 inch: 5V or 5V +12V SATA Supply Rail<sup>10</sup>
  - SATA Interface Power Management
  - OS-aware hot plug/removal
  - Enhanced power-loss data protection
- **Power<sup>11</sup>**
  - Active: Up to 5.2 W (TYP)
  - Idle: 700 mW
- **Weight**
  - 94 grams ± 2 grams
- **Temperature**
  - Operating: 0° C to 70° C
  - Non-Operating<sup>12</sup>: -55° C to 95° C
  - Temperature monitoring and logging
  - Thermal throttling
- **Shock (operating and non-operating):**
  - 1,000 G/0.5 msec
- **Vibration**
  - Operating: 2.17 G<sub>RMS</sub> (5-700 Hz)
  - Non-Operating: 3.13 G<sub>RMS</sub> (5-800 Hz)
- **Reliability**
  - Uncorrectable Bit Error Rate (UBER):  
1 sector per 10<sup>17</sup> bits read
  - Mean Time Between Failures (MTBF):  
2 million hours
  - End-to-End data protection
- **Endurance Rating<sup>13</sup>**
  - 1.2TB: 660 TBW
  - 1.6TB: 880 TBW
- **Certifications and Declarations**
  - UL\*, CE\*, C-Tick\*, BSMI\*, KCC\*, Microsoft WHCK\*, VCCI\*, SATA-IO

1. The 2.5 form factor is identical to the S3500 lower capacity models.

2. Performance values vary by capacity

3. Performance specifications apply to both compressible and incompressible data

4. 4KB = 4,096 bytes; 8KB = 8,192 bytes

5. MB/s = 1,000,000 bytes/second.

6. Based on Random 4KB QD=1 workload, measured as the time taken for 99.9 percentile of commands to finish the round-trip from host to drive and back to host

7. Measurement taken once the workload has reached steady state but including all background activities required for normal operation and data reliability

8. Altitude pressure is simulated in a test chamber; excludes soft error

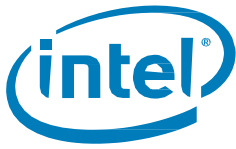
9. Extended operation at a higher altitude might impact reliability.

10. If both 5V and 12V power supplies are present, will source power from both. 5V must be present

11. Based on 5V power supply only

12. Please contact your Intel representative for details on the non-operating temperature range

13. Based on JESD218 standard



## Ordering Information

Contact your local Intel sales representative for ordering information.

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Intel Non-Volatile Memory Solutions Group (NSG) states that, through our Software Legal Compliance (SWLC) process, we have examined and evaluated firmware and software components that may accompany this Intel Solid-State Drive product, including embedded SSD firmware and any Intel-provided drivers. We conclude that there are no Open Source elements contained in these components. For more information about our SWLC process, please contact your Intel Representative.

Contact your local Intel sales office or your distributor to obtain the latest specifications and before placing your product order.

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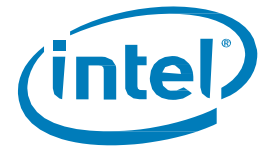
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## Revision History

| Revision | Description  | Date          |
|----------|--|---------------|
| 001      | Initial release.   | November 2014 |
| 002      | Updated description and value of word 106 in Appendix A's Returned Sector Data table.                                      | January 2015  |
| 003      | Added 3 new sections, i.e., Supported Command Sets, SMART Attributes and Certifications and Declarations to this document. | July 2015     |

## Related Document

| Title  | Link  |
|--|---|
| Intel® Solid-State Drive DC S3500 Series Product Specification | <a href="http://www.intel.com/content/dam/www/public/us/en/documents/product-specifications/ssd-dc-s3500-spec.pdf">http://www.intel.com/content/dam/www/public/us/en/documents/product-specifications/ssd-dc-s3500-spec.pdf</a> |



## 1 Overview

This document is an addendum to the Intel® SSD DC S3500 Series and outlines the differences between the previously released products and the higher capacity 1.2TB and 1.6TB products.

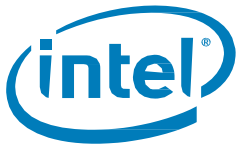
The Intel SSD DC S3500 Series delivers leading performance and Quality of Service combined with world-class reliability for Serial Advanced Technology Attachment (SATA)-based computers. These two new models extend the storage capacities of the existing Intel SSD DC S3500 Series.

By combining 20nm Intel® SSD NAND Flash Memory technology with SATA 6Gb/s interface support, the Intel SSD DC S3500 Series delivers sequential read speeds of up to 500 MB/s and sequential write speeds of up to 450 MB/s. Intel SSD DC S3500 Series delivers Quality of Service of 500 us for random 4KB reads measured at a queue depth of 1.

Intel SSD DC S3500 Series offers these key features:

- Standard Endurance Technology
- High I/O and throughput performance
- Consistent I/O latency
- Enhanced power-loss data protection
- End-to-End data protection
- Thermal throttling
- Temperature Sensor
- Inrush current management
- Low power
- High reliability
- Enhanced ruggedness
- Temperature monitor and logging
- Power loss protection capacitor self-test

The 2.5 form factor is identical to Intel SSD DC S3500 Series lower capacity models. For the full mechanical specifications, see the [Intel® Solid-State Drive DC S3500 Series Product Specification](#).



## 2 Product Specifications

### 2.1 Capacity

**Table 1: User Addressable Sectors**

| Intel SSD DC S3500 Series | Unformatted Capacity<br>(Total User Addressable Sectors in LBA Mode) |
|---------------------------|--|
| 1.2TB <sup>1</sup>        | 2,344,225,968 <sup>2</sup>   |
| 1.6TB <sup>1</sup>        | 3,125,627,568 <sup>2</sup>   |

**Notes:**

- 1TB = 1,000,000,000,000 (trillion) bytes; 1 sector = 512 bytes.
- LBA count shown represents total user storage capacity and will remain the same throughout the life of the drive.

### 2.2 Performance

**Table 2: Random Read/Write Input/Output Operations Per Second (IOPS)**

| Specification <sup>1</sup>           | Unit | Intel SSD DC S3500 Series |        |
|--------------------------------------|------|---------------------------|--------|
|                                      |      | 1.2TB                     | 1.6TB  |
| Random 4KB Read (up to) <sup>2</sup> | IOPS | 65,500                    | 65,000 |
| Random 4KB Write (up to)             | IOPS | 15,500                    | 14,600 |
| Random 8KB Read (up to) <sup>3</sup> | IOPS | 44,500                    | 44,000 |
| Random 8KB Write (up to)             | IOPS | 8,000                     | 7,500  |

**Notes:**

- Performance measured using IOMeter\* with Queue Depth 32. Measurements are performed on a full Logical Block Address (LBA) span of the drive.
- 4KB = 4,096 bytes
- 8KB = 8,192 bytes

**Table 3: Random Read/Write IOPS Consistency**

| Specification <sup>1</sup>            | Unit | Intel SSD DC S3500 Series |       |
|---------------------------------------|------|---------------------------|-------|
|                                       |      | 1.2TB                     | 1.6TB |
| Random 4 KB Read (up to) <sup>2</sup> | %    | 90                        | 90    |
| Random 4 KB Write (up to)             | %    | 80                        | 80    |
| Random 8 KB Read (up to) <sup>3</sup> | %    | 90                        | 90    |
| Random 8 KB Write (up to)             | %    | 80                        | 80    |

**Notes:**

- Performance consistency measured using IOMeter\* based on Random 4KB QD=32 workload, measured as the (IOPS in the 99.9th percentile slowest 1-second interval)/(average IOPS during the test). Measurements are performed on a full Logical Block Address (LBA) span of the drive once the workload has reached steady state but including all background activities required for normal operation and data reliability.
- 4KB = 4,096 bytes
- 8KB = 8,192 bytes

**Table 4: Sequential Read and Write Bandwidth**

| Specification                              | Unit | Intel SSD DC S3500 Series |       |
|--|------|---------------------------|-------|
|  |      | 1.2TB                     | 1.6TB |
| Sequential Read (SATA 6Gb/s) <sup>1</sup>  | MB/s | 500                       | 500   |
| Sequential Write (SATA 6Gb/s) <sup>1</sup> | MB/s | 460                       | 460   |

**Note:**

1. Performance measured using IOMeter\* with 128 KB (131,072 bytes) of transfer size with Queue Depth 32.

**Table 5: Latency**

| Specification                  | Intel SSD DC S3500 Series |            |
|--------------------------------|---------------------------|------------|
|                                | 1.2TB                     | 1.6TB      |
| Latency <sup>1</sup> (TYP)     |                           |            |
| Read                           | 50 $\mu$ s                | 50 $\mu$ s |
| Write                          | 65 $\mu$ s                | 65 $\mu$ s |
| Power On to Ready <sup>2</sup> | 6.0 s                     | 7.0 s      |

**Notes:**

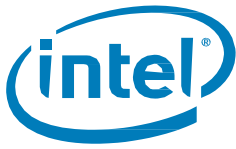
1. Device measured using IOMeter. Latency measured using 4KB (4,096 bytes) transfer size with Queue Depth equal to 1 on a sequential workload.
2. Power On To Ready time assumes proper shutdown. Time varies if shutdown is not preceded by STANDBY IMMEDIATE command.

**Table 6: Quality of Service**

| Specification                                      | Unit | Intel SSD DC S3500 Series |       |                |       |
|--|------|---------------------------|-------|----------------|-------|
|  |      | Queue Depth=1             |       | Queue Depth=32 |       |
|  |      | 1.2TB                     | 1.6TB | 1.2TB          | 1.6TB |
| <b>Quality of Service<sup>1,2</sup> (99.9%)</b>    |      |                           |       |                |       |
| Reads  | ms   | 0.5                       | 0.5   | 5              | 5     |
| Writes   | ms   | 5                         | 0.5   | 15             | 10    |
| <b>Quality of Service<sup>1,2</sup> (99.9999%)</b> |      |                           |       |                |       |
| Reads  | ms   | 5                         | 5     | 5              | 10    |
| Writes   | ms   | 15                        | 10    | 20             | 20    |

**Notes:**

1. Device measured using IOMeter. Quality of Service measured using 4KB (4,096 bytes) transfer size on a random workload on a full Logical Block Address (LBA) span of the drive once the workload has reached steady state but including all background activities required for normal operation and data reliability.
2. Based on Random 4KB QD=1, 32 workloads, measured as the time taken for 99.9(or 99.9999) percentile of commands to finish the round-trip from host to drive and back to host.



## 2.3 Electrical Characteristics

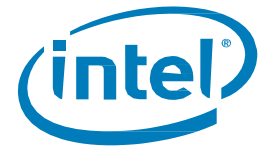
Table 7: Operating Voltage for 2.5-inch Form Factor

| Electrical Characteristics                 | Intel SSD DC S3500 Series                                |
|--|--|
|  | 1.2TB/1.6TB  |
| <b>5 V Operating Characteristics:</b>      |  |
| Operating Voltage range                    | 5 V (±5%)  |
| Rise time (Max/Min)                        | 1 s / 1 ms   |
| Fall time (Min) <sup>2</sup>               | 1 ms   |
| Noise level                                | 500 mV pp 10 Hz – 100 KHz<br>50 mV pp 100 KHz – 20 MHz   |
| Min Off time <sup>3</sup>                  | 500 ms   |
| Inrush Current (Typical Peak) <sup>1</sup> | 1.2 A, < 1 s   |
| <b>12 V Operating Characteristics:</b>     |  |
| Operating Voltage range                    | 12 V (±10%)  |
| Rise time (Max/Min)                        | 1 s / 1 ms   |
| Fall time (Min) <sup>2</sup>               | 1 ms   |
| Noise level                                | 1000 mV pp 10 Hz – 100 KHz<br>100 mV pp 100 KHz – 20 MHz |
| Min Off time <sup>3</sup>                  | 500 ms   |
| Inrush Current (Typical Peak) <sup>1</sup> | 1.2 A, < 1 s   |

**Notes:**

1. Measured from initial device power supply application.
2. Fall time needs to be equal or better than minimum in order to guarantee full functionality of enhanced power loss management.
3. The drive needs to be powered off for at least 500 msec before powering on.

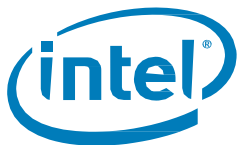


**Table 8: Power Consumption for 2.5-inch Form Factor (5V Supply)**

| Specification                             | Unit | Intel SSD DC S3500 Series |       |
|---|------|---------------------------|-------|
|   |      | 1.2TB                     | 1.6TB |
| Active Write - RMS Average <sup>1</sup>   | W    | 5.0                       | 5.2   |
| Active Write - RMS Burst <sup>2</sup>     | W    | 6.9                       | 7.2   |
| Active Write - RMS MAX Burst <sup>3</sup> | W    | 8.7                       | 8.7   |
| Active Read - RMS Average <sup>4</sup>    | W    | 2.5                       | 2.5   |
| Active Read - RMS Burst <sup>5</sup>      | W    | 3.0                       | 3.4   |
| Active Read - RMS MAX Burst <sup>6</sup>  | W    | 4.8                       | 4.8   |
| Idle                                      | W    | 0.7                       | 0.7   |

**Notes:**

1. The workload equates 128 KB (131,072 bytes) Queue Depth equal to 32 sequential writes. RMS (Root Mean Squared) Average Power is measured using Agilent Power Analyzer over a 100 ms sample period with PLI capacitor charge enabled.
2. The workload equates 128 KB (131,072 bytes) Queue Depth equal to 32 sequential writes. RMS (Root Mean Squared) Burst Power is measured using Agilent Power Analyzer over a 500  $\mu$ s sample period with PLI capacitor charge disabled.
3. The workload equates 128 KB (131,072 bytes) Queue Depth equal to 32 sequential writes. RMS (Root Mean Squared) Max burst power is measured using Agilent Power Analyzer over a 500  $\mu$ s sample period with PLI capacitor charge enabled. Pulse is 0.25% of total time.
4. The workload equates 128 KB (131,072 bytes) Queue Depth equal to 32 sequential reads. RMS (Root Mean Squared) Average power is measured using Agilent Power Analyzer over a 100 ms sample period with PLI capacitor charge enabled.
5. The workload equates 128 KB (131,072 bytes) Queue Depth equal to 32 sequential reads. RMS (Root Mean Squared) Burst power is measured using Agilent Power Analyzer over a 500  $\mu$ s sample period with PLI capacitor charge disabled.
6. The workload equates 128 KB (131,072 bytes) Queue Depth equal to 32 sequential reads. RMS (Root Mean Squared) Max Burst power is measured using Agilent Power Analyzer over a 500  $\mu$ s sample period with PLI capacitor charge enabled. Pulse is approximately 0.25% of total time.

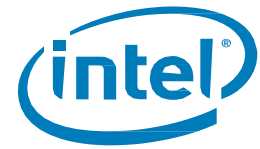


**Table 9: Power Consumption for 2.5-inch Form Factor (5V and 12V Supply)**

| Specification                             | Unit | Intel SSD DC S3500 Series |      |       |      |
|---|------|---------------------------|------|-------|------|
|   |      | 1.2TB                     |      | 1.6TB |      |
|   |      | 5V                        | 12V  | 5V    | 12V  |
| Active Write - RMS Average <sup>1</sup>   | W    | 1.9                       | 2.9  | 2.0   | 3.4  |
| Active Write - RMS Burst <sup>2</sup>     | W    | 2.5                       | 5.5  | 2.6   | 6.0  |
| Active Write - RMS MAX Burst <sup>3</sup> | W    | 4.3                       | 5.7  | 4.2   | 6.0  |
| Active Read - RMS Average <sup>4</sup>    | W    | 1.3                       | 0.01 | 1.3   | 0.01 |
| Active Read - RMS Burst <sup>5</sup>      | W    | 2.1                       | 0.1  | 2.0   | 0.1  |
| Active Read - RMS MAX Burst <sup>6</sup>  | W    | 3.6                       | 0.2  | 3.5   | 0.3  |
| Idle                                      | W    | 0.7                       | 0.01 | 0.7   | 0.01 |

**Notes:**

1. The workload equates 128 KB (131,072 bytes) Queue Depth equal to 32 sequential writes. RMS (Root Mean Squared) Average Power is measured using Agilent Power Analyzer over a 100 ms sample period with PLI capacitor charge enabled.
2. The workload equates 128 KB (131,072 bytes) Queue Depth equal to 32 sequential writes. RMS (Root Mean Squared) Burst Power is measured using Agilent Power Analyzer over a 500 μs sample period with PLI capacitor charge disabled.
3. The workload equates 128 KB (131,072 bytes) Queue Depth equal to 32 sequential writes. RMS (Root Mean Squared) Max burst power is measured using Agilent Power Analyzer over a 500 us sample period with PLI capacitor charge enabled. Pulse is 0.25% of total time.
4. The workload equates 128 KB (131,072 bytes) Queue Depth equal to 32 sequential reads. RMS (Root Mean Squared) Average power is measured using Agilent Power Analyzer over a 100 ms sample period with PLI capacitor charge enabled.
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6. The workload equates 128 KB (131,072 bytes) Queue Depth equal to 32 sequential reads. RMS (Root Mean Squared) Max Burst power is measured using Agilent Power Analyzer over a 500 us sample period with PLI capacitor charge enabled. Pulse is approximately 0.25% of total time.



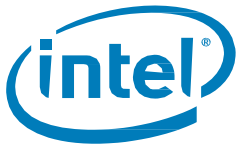
## 2.4 Environmental Conditions

**Table 10: Temperature, Shock, Vibration for Intel SSD DC 3500 2.5-inch Form Factor**

| Temperature   | Range  |
|---|--|
| Case Temperature<br>Operating<br>Non-operating <sup>1</sup>     | 0 – 70 °C<br>-55 – 95 °C   |
| Temperature Gradient <sup>2</sup><br>Operating<br>Non-operating | 30 °C/hr (Typical)<br>30 °C/hr (Typical)                             |
| Humidity<br>Operating<br>Non-operating                          | 5 – 95 %<br>5 – 95 %   |
| Shock and Vibration   | Range  |
| Shock <sup>3</sup><br>Operating<br>Non-operating                | 1,000 G (Max) at 0.5 msec<br>1,000 G (Max) at 0.5 msec               |
| Vibration <sup>4</sup><br>Operating<br>Non-operating            | 2.17 G <sub>RMS</sub> (5-700 Hz)<br>3.13 G <sub>RMS</sub> (5-800 Hz) |

**Notes:**

1. Contact your Intel representative for details on the non-operating temperature range.
2. Temperature gradient measured without condensation.
3. Shock specifications assume the SSD is mounted securely with the input vibration applied to the drive-mounting screws. Stimulus may be applied in the X, Y or Z axis. Shock specification is measured using Root Mean Squared (RMS) value.
4. Vibration specifications assume the SSD is mounted securely with the input vibration applied to the drive-mounting screws. Stimulus may be applied in the X, Y or Z axis. Vibration specification is measured using RMS value.

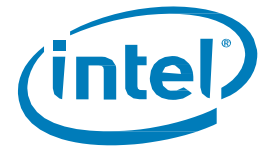


## 2.5 Product Regulatory Compliance

Intel SSD DC S3500 Series meets or exceeds the regulatory or certification requirements listed in the following table:

**Table 11: Product Regulatory Compliance Specifications**

| Title  | Description  | Region For Which Conformity Declared |
|--|--|--------------------------------------|
| TITLE 47-Telecommunications CHAPTER 1— FEDERAL COMMUNICATIONS COMMISSION PART 15 — RADIO FREQUENCY DEVICES<br><br>ICES*-003, Issue 4 Interference-Causing Equipment Standard Digital Apparatus | FCC Part 15B Class B<br><br>CA/CSA-CEI/IEC CISPR 22-10 (Ref. CISPR 22:2008). | USA<br><br>Canada                    |
| IEC* 55024 Information Technology Equipment — Immunity characteristics— Limits and methods of measurement CISPR24:2010   | EN-55024: 2010 and its amendments  | European Union                       |
| IEC* 55022 Information Technology Equipment — Radio disturbance Characteristics— Limits and methods of measurement CISPR22:2008 (Modified)   | EN-55022: 2010 and its amendments  | European Union                       |
| EN-60950-1 2nd Edition   | Information Technology Equipment — Safety — Part 1: General Requirements     | USA/Canada                           |
| UL/CSA EN-60950-1 2nd Edition  | Information Technology Equipment — Safety — Part 1: General Requirements     | USA/Canada                           |



## 2.6 Reliability

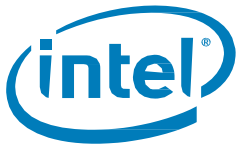
Intel SSD DC S3500 Series meets or exceeds SSD endurance and data retention requirements as specified in the JESD218 standard. Reliability specifications are listed in the following table.

**Table 12: Reliability Specifications**

| Parameter   | Value  |
|---|--|
| <b>Uncorrectable Bit Error Rate (UBER)</b><br>Uncorrectable bit error rate will not exceed one sector in the specified number of bits read. In the unlikely event of a non-recoverable 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. | < 1 sector per 10 <sup>17</sup> bits read                                    |
| <b>Mean Time Between Failures (MTBF)</b><br>Mean Time Between Failures is estimated based on Telcordia* methodology and demonstrated through Reliability Demonstration Test (RDT).  | 2 million hours  |
| <b>Power On/Off Cycles</b><br>Power On/Off Cycles is defined as power being removed from the SSD, and then restored. Most host systems remove power from the SSD when entering suspend and hibernate as well as on a system shutdown.   | 24 per day   |
| <b>Insertion Cycles</b><br>SATA/power cable insertion/removal cycles.   | 50 on SATA cable<br>500 on backplane   |
| <b>Data Retention</b><br>The time period for retaining data in the NAND at maximum rated endurance.   | 3 months power-off retention once SSD reaches rated write endurance at 40 °C |
| <b>Endurance Rating<sup>1</sup></b><br>The number of drive writes such that the SSD meets the requirements according to the JESD2182 standard and JESD219 workload  | 1.2TB: Up to 660 TBW<br>1.6: Up to 880 TBW                                   |

**Note:**

1. Refer to JESD218 standard table 1 for UBER, FFR and other Enterprise SSD endurance verification requirements. UBER design and majority of life target is 1E-17. Endurance verification acceptance criterion based on establishing <1E-16 at 60 confidence.



### 3 Supported Command Sets

The Intel SSD DC S3500 Series HD supports all mandatory ATA (Advanced Technology Attachment) commands defined in the ATA8-ACS specification described in this section.

#### 3.1 ATA General Feature Command Set

The Intel SSD DC S3500 Series HD supports the ATA General Feature command set (non-PACKET), which consists of:

- EXECUTE DEVICE DIAGNOSTIC
- SET FEATURES
- IDENTIFY DEVICE

**Note:** See Appendix A, “IDENTIFY DEVICE Command Data” for details on the sector data returned after issuing an IDENTIFY DEVICE command.

The Intel SSD DC S3500 Series HD also supports the following optional commands:

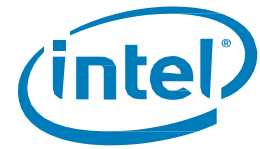
- READ DMA
- WRITE DMA
- READ SECTOR(S)
- READ VERIFY SECTOR(S)
- READ MULTIPLE
- SEEK
- SET FEATURES
- WRITE SECTOR(S)
- SET MULTIPLE MODE<sup>1</sup>
- WRITE MULTIPLE
- FLUSH CACHE
- READ BUFFER
- WRITE BUFFER
- NOP
- DOWNLOAD MICROCODE
- WRITE UNCORRECTABLE EXT

1. The only multiple supported will be multiple 1

#### 3.2 Power Management Command Set

The Intel SSD DC S3500 Series HD supports the Power Management command set, which consists of:

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



### 3.3 Security Mode Feature Set

The Intel SSD DC S3500 Series HD 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

### 3.4 SMART Command Set

The Intel SSD DC S3500 Series HD 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
- SMART ENABLE/DISABLE AUTOMATIC OFFLINE

#### 3.4.1 Attributes

Table 13 lists the SMART attributes supported by the Intel SSD DC S3500 Series HD and the corresponding status flags and threshold settings.

**Table 13: SMART Attributes**

| ID  | Attribute  | Status Flags |    |    |    |    |    | Threshold |
|-----|--|--------------|----|----|----|----|----|-----------|
|     |  | SP           | EC | ER | PE | OC | PW |           |
| 05h | Re-allocated Sector Count<br>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<br>The raw value reports power-on time, cumulative over the life of the SSD, integer number in hour time units.   | 1            | 1  | 0  | 0  | 1  | 0  | 0 (none)  |
| 0Ch | Power Cycle Count<br>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 (See Attribute E8)  | 1            | 1  | 0  | 0  | 1  | 1  | 10        |
| ABh | Program Fail Count<br>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)  |

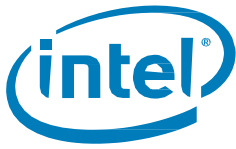


| ID  | Attribute   | Status Flags |    |    |    |    |    | Threshold |
|-----|---|--------------|----|----|----|----|----|-----------|
|     |   | SP           | EC | ER | PE | OC | PW |           |
| ACh | <p>Erase Fail Count</p> <p>The raw value of this attribute shows total count of erase fails and the normalized value, beginning at 100, shows the percent remaining of allowable erase fails.</p>   | 1            | 1  | 0  | 0  | 1  | 0  | 0 (none)  |
| AEh | <p>Unexpected Power Loss</p> <p>Also known as "Power-off Retract Count" per magnetic-drive terminology.</p> <p>Reports number of unclean shutdowns, cumulative over the life of the SSD.</p> <p>An "unclean shutdown" is the removal of power without STANDBY IMMEDIATE as the last command (regardless of PLI activity using capacitor power).</p>   | 1            | 1  | 0  | 0  | 1  | 0  | 0 (none)  |
| AFh | <p>Power Loss Protection Failure</p> <p>Last test result as microseconds to discharge cap, saturates at max value. Also logs minutes since last test and lifetime number of tests.</p> <p>Bytes 0-1: Last test result as microseconds to discharge cap, saturates at max value. Test result expected in range 25 &lt;= result &lt;= 5000000, lower indicates specific error code</p> <p>Bytes 2-3: Minutes since last test, saturates at max value.</p> <p>Bytes 4-5: Lifetime number of tests, not incremented on power cycle, saturates at max value.</p> | 1            | 1  | 0  | 0  | 1  | 1  | 10        |
| B7h | <p>SATA Downshift Count</p> <p>The count of the number of times SATA interface selected lower signaling rate due to error.</p>  | 1            | 1  | 0  | 0  | 1  | 0  | 0 (none)  |
| B8h | <p>End-to-End Error Detection Count</p> <p><i>Raw value:</i> reports number of LBA tag mismatches in end-to-end data protection path.</p> <p><i>Normalized value:</i> always 100.</p>   | 1            | 1  | 0  | 0  | 1  | 1  | 90        |
| BBh | <p>Uncorrectable Error Count</p> <p>The raw value shows the count of errors that could not be recovered using Error Correction Code (ECC).</p> <p><i>Normalized value:</i> always 100.</p>  | 1            | 1  | 0  | 0  | 1  | 0  | 0 (none)  |
| BEh | <p>Temperature - Airflow Temperature (Case) Reports the SSD case temperature.</p> <p>Raw value suggests 100 - case temperature in C degrees.</p>  | 1            | 0  | 0  | 0  | 1  | 0  | 0 (none)  |
| C0h | <p>Power-Off Retract Count (Unsafe Shutdown Count)</p> <p>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 STANDBYIMMEDIATE being the last command.</p>  | 1            | 1  | 0  | 0  | 1  | 0  | 0 (none)  |
| C2h | <p>Temperature - Device Internal Temperature</p> <p>Reports internal temperature of the SSD. Temperature reading is the value direct from the printed circuit board (PCB) sensor without offset.</p>  | 1            | 0  | 0  | 0  | 1  | 0  | 0 (none)  |





| ID  | Attribute   | Status Flags |    |    |    |    |    | Threshold |
|-----|---|--------------|----|----|----|----|----|-----------|
|     |   | SP           | EC | ER | PE | OC | PW |           |
| C5h | Pending Sector Count<br>Number of current unrecoverable read errors that will be re-allocated on next write.  | 0            | 1  | 0  | 0  | 1  | 0  | 0 (none)  |
| C7h | CRC Error Count<br>The total number of encountered SATA interface cyclic redundancy check (CRC) errors.   | 1            | 1  | 0  | 0  | 1  | 0  | 0 (none)  |
| E1h | Host Writes<br>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<br>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<br>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<br>Measures the elapsed time (number of minutes since starting this workload timer).   | 1            | 1  | 0  | 0  | 1  | 0  | 0 (none)  |
| E8h | Available Reserved Space<br>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        |
| E9h | Media Wearout Indicator<br>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.<br>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)  |
| EAh | Thermal Throttle Status<br>Reports Percent Throttle Status and Count of events<br>Byte 0 = Throttling status. Decimal value 0 = No Throttle Applied, 100 = 100% throttling applied. Intermediate percentages are supported. A value larger than 100d is invalid.<br>Bytes 1-4 = Throttling event count. 32 bit counter indicates the number of times thermal throttle has activated. Value is preserved over power cycles.<br>Byte 5 = Reserved | 1            | 1  | 0  | 0  | 1  | 0  | 0 (none)  |



| ID  | Attribute  | Status Flags |    |    |    |    |    | Threshold |
|-----|--|--------------|----|----|----|----|----|-----------|
|     |  | SP           | EC | ER | PE | OC | PW |           |
| F1h | Total LBAs Written<br>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<br>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)  |
| F3h | Total Bytes Written<br>The raw value of this attribute reports the total number of sectors written to the NAND media. This includes NAND writes triggered by host writes, defrag, background data refresh and wear level relocation writes etc. The raw value is increased by 1 for every 65,536 sectors (32MB) writes to the NAND media. Upon NAND write, new value returned once per minute. | 1            | 1  | 0  | 0  | 1  | 0  | 0 (none)  |

**Table 14: 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  |

**3.4.2 Timed Workload Endurance Indicators**

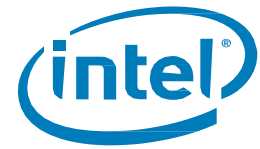
**Timed Workload Media Wear Indicator — ID E2h**

This attribute tracks the drive wear seen by the device during the last wear timer loop, as a percentage of the maximum rated cycles. The raw value tracks the percentage up to 2 decimal precision points. This value should be divided by 1024 to get the percentage.

For example: if the raw value is 4455, the percentage is  $4455/1024 = 4.35\%$ . The raw value is held at FFFFh until the wear timer (attribute E4h) reaches 60 (minutes) after a SMART EXECUTE OFFLINE IMMEDIATE (B0h/D4h) subcommand 40h to the SSD. The normalized value is always set to 100 and should be ignored.

**Timed Workload Host Reads Percentage — ID E3h**

This attribute shows the percentage of I/O operations that are read operations during the last workload timer loop. The raw value tracks this percentage and is held at FFFFh until the workload timer (attribute E4h) reaches 60 (minutes). The normalized value is always set to 100 and should be ignored.



### Workload Timer — ID E4h

This attribute is used to measure the time elapsed during the current workload. The attribute is reset when a SMART EXECUTE OFFLINE IMMEDIATE (D4h) subcommand 40h is issued to the drive. The raw value tracks the time in minutes and has a maximum value of 232 = 4,294,967,296 minutes (8,171 years). The normalized value is always set to 100 and should be ignored.

### User Notes

- Sending a SMART EXECUTE OFFLINE IMMEDIATE (B0h/D4h) subcommand 40h to the SSD resets and starts all three attributes (Media Wear Indicator, Attribute E2h, Host Reads Percentage, Attribute E3h, and the Workload timer, Attribute E4h to FFFFh).
- The Attribute raw values are held at FFFFh until the Workload timer (Attribute E4h) reaches a total of 60 (minutes) of power on time. After 60 minutes, the Timed Workload data is made available.
- After the Workload timer (E4h) reaches 60 (minutes), the Timed Workload data is saved every minute so only 59 seconds of data is lost if power is removed without receiving ATA STANDBY IMMEDIATE. Accumulated data is not reset due to power loss.
- Upon power up, the attributes hold a snapshot of their last saved values for 59 seconds and live data is available after 60 seconds, once the initial one hour interval is completed.

### Example Use Cases

The Timed Workload Endurance attributes described in this section are intended to be used to measure the amount of media wear that the drive is subjected to during a timed workload.

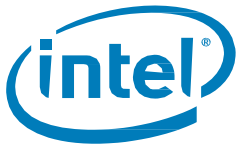
Ideally, the system that the drive is being used in should be capable of issuing SMART commands. Otherwise, provisions have been provided to allow the media wear attributes to be persistent so the drive can be moved to a SMART capable system to read out the drive wear attribute values.

#### Use Case 1 – With a System Capable of SMART Commands

1. On a SMART capable system, issue the SMART EXECUTE OFF-LINE IMMEDIATE (D4h) sub-command 40h to reset the drive wear attributes.
2. Run the workload to be evaluated for at least 60 minutes. Otherwise the drive wear attributes will not be available.
3. Read out the drive wear attributes with the SMART READ DATA (D0h) command.

#### Use Case 2 – With a System Not Capable of SMART Commands

1. On a SMART capable system, issue the SMART EXECUTE OFF-LINE IMMEDIATE (D4h) sub-command 40h to reset the drive wear attributes.
2. Move the drive to the system where the workload will be measured (and not capable of SMART commands).
3. Run the workload to be evaluated for at least 60 minutes. Otherwise the drive wear attributes will not be available.
4. Do a clean system power down by issuing the ATA STANDBY IMMEDIATE command prior to shutting down the system. This will store all the drive wear SMART attributes to persistent memory within the drive.
5. Move the drive to a SMART capable system.



6. Read out the drive wear attributes with the SMART READ DATA (D0h) command within 59 seconds after power-up.

#### Example Calculation of Drive Wear

The following is an example of how the drive wear attributes can be used to evaluate the impact of a given workload. The Host Writes SMART attribute (E1h) can also be used to calculate the amount of data written by the host during the workload by reading this attribute before and after running the workload. This example assumes that the steps shown in "Example Use Cases" on page 18 were followed to obtain the following attribute values:

- Timed Workload Media Wear (E2h) has a raw value of 16. Therefore, the percentage wear =  $16/1024 = 0.016\%$ .
- Timed Workload Host Read/Write Ratio (E3h) has a normalized value of 80, indicating that 80% of operations were reads.
- Workload Timer (E4h) has a raw value of 500. Therefore the workload ran for 500 minutes.
- Host Writes Count (E1h) had a raw value of 100,000 prior to running the workload and a value of 130,000 at the end of the workload. Therefore, the number of sectors written by the host during the workload was  $30,000 * 65,535 = 1,966,050,000$  sectors or  $1,966,050,000 * 512/1,000,000,000 = 1,007$  GB.

The following conclusions can be made for this example case:

The workload took 500 minutes to complete with 80% reads and 20% writes. A total of 1,007 GB of data was written to the device, which increased the media wear in the drive by 0.016%. At this point in time, this workload is causing a wear rate of 0.016% for every 500 minutes, or 0.00192%/hour.

### 3.4.3 SMART Logs

The Intel SSD DC S3500 Series HD implements the following Log Addresses: 00h, 02h, 03h, 06h, and 07h.

The DC S3500 Series HD implements host vendor specific logs (addresses 80h-9Fh) as read and write scratchpads, where the default value is zero (0). Intel® SSD DC S3510 does not write any specific values to these logs unless directed by the host through the appropriate commands.

The DC S3500 Series HD also implements a device vendor specific log at address A9h as a read-only log area with a default value of zero (0). Besides that, the DC S3500 Series HD also implements log address B8h (if the drive is in disable logical mode, log address B8h will have the word error code for \*BAD\_CTX). Finally the DC S3500 Series HD also implements log at addresses B9h and BAh (both of them are Intel error logs, and read only for customers).

## 3.5 Device Statistics

In addition to the SMART attribute structure, statistics pertaining to the operation and health of the Intel SSD DC S3500 Series HD can be reported to the host on request through the Device Statistics log as defined in the ATA specification.

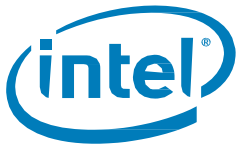
The Device Statistics log is a read-only GPL/SMART log located at read log address 0x04 and is accessible using READ LOG EXT, READ LOG DMA EXT or SMART READ LOG commands.

Table 20 lists the Device Statistics supported by the Intel SSD DC S3500 Series HD.



Table 15: Serial ATA Power Pin Definitions—2.5-inch Form Factors

| 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 | --  |
|                                      | 0x28   | Logical Sectors Read   | F2h   |
|                                      | 0x30   | Num Read Commands – incremented by one for every host read   | --  |
| 0x04 – General Error Statistics      | 0x08   | Num Reported Uncorrectable Errors                            | BBh   |
|                                      | 0x10   | Num Resets Between Command Acceptance and Completion         | --  |
| 0x05 – Temperature Statistics        | 0x00   | Device Statistics Information Header                         | --  |
|                                      | 0x08   | Current Temperature  | --  |
|                                      | 0x10   | Average Short Term Temperature                               | --  |
|                                      | 0x18   | Average Long Term Temperature                                | --  |
|                                      | 0x20   | Highest Temperature  | --  |
|                                      | 0x28   | Lowest Temperature   | --  |
|                                      | 0x30   | Highest Average Short Term Temperature                       | --  |
|                                      | 0x38   | Lowest Average Short Term Temperature                        | --  |
|                                      | 0x40   | Highest Average Long Term Temperature                        | --  |
|                                      | 0x48   | Lowest Average Long Term Temperature                         | --  |
|                                      | 0x50   | Time in Over-Temperature                                     | --  |
|                                      | 0x58   | Specified Maximum Operating Temperature                      | --  |
|                                      | 0x60   | Time in Under-Temperature                                    | --  |
|                                      | 0x68   | Specified Minimum Operating Temperature                      | --  |
| 0x06 – Transport Statistics          | 0x08   | Number of Hardware Resets                                    | --  |
|                                      | 0x10   | Number of ASR Events   | --  |
|                                      | 0x18   | Number of Interface CRC Errors                               | --  |
| 0x07 – Solid State Device Statistics | 0x08   | Percentage Used Endurance Indicator                          | E9h<br>Note: This device statistic counts from 1 to 150 |



### 3.6 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

Intel SSD DC S3510 supports the following standard SCT actions:

- Write Same — DC S3500 Series HD implements this action code as described in the ATA specification.
- Error Recovery Control — DC S3500 Series HD accepts this action code, and will store and return error-recovery time limit values.
- Feature Control - DC S3500 Series HD supports feature code 0001h (write cache) feature code 0002h (write cache reordering), and feature code 0003h (time interval for temperature logging). It also supports D000h (Power Safe Write Cache capacitor test interval), D001h (read/write power governor mode), D002h (read thermal governor mode), D003h (read power governor burst power), and D004h (read power governor average power).
- Data table command - DC S3500 Series HD supports data table command as specified in ATA8-ACS2. This will read out temperature logging information in table ID 0002h.
- Read Status Support - DC S3510 supports read status log
- By using SCT command 0xD801 with State=0, Option=1, ID Word 106 can be changed from 0x6003 to 0x4000 (4KB physical sector size to 512B physical sector size support change).

### 3.7 Data Set Management Command Set

Intel SSD DC S3500 Series HD supports the Data Set Management command set Trim attribute, which consists of:

- DATA SET MANAGEMENT

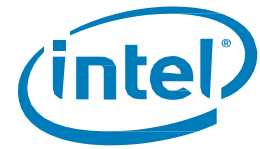
### 3.8 Host Protected Area Command Set

Intel SSD DC S3500 Series HD 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

Intel SSD DC S3500 Series HD also supports the following optional commands:

- SET MAX SET PASSWORD
- SET MAX LOCK
- SET MAX FREEZE LOCK
- SET MAX UNLOCK



### 3.9 48-Bit Address Command Set

Intel SSD DC S3500 Series HD supports the 48-bit Address command set, which consists of:

- FLUSH CACHE EXT
- READ DMA EXT
- 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
- WRITE MULTIPLE FUA EXT
- WRITE DMA FUA EXT

### 3.10 General Purpose Log Command Set

Intel SSD DC S3500 Series HD supports the General Purpose Log command set, which consists of:

- READ LOG EXT
- WRITE LOG EXT

### 3.11 Native Command Queuing

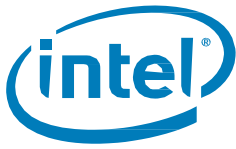
Intel SSD DC S3500 Series HD supports the Native Command Queuing (NCQ) command set, which includes:

- READ FPDMA QUEUED
- WRITE FPDMA QUEUED

**Note:** With a maximum Queue Depth set to 32.

### 3.12 Software Settings Preservation

Intel SSD DC S3500 Series HD supports the SET FEATURES parameter to enable/disable the preservation of software settings.



## 4 Certifications and Declarations

Table 21 describes the Device Certifications supported by the Intel SSD DC S3500 Series HD .

**Table 16: Device Certifications and Declarations**

| <b>Certification</b> | <b>Description</b>   |
|----------------------|--|
| 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.   |
| UL Recognized        | Underwriters Laboratories, Inc. Bi-National Component Recognition; UL 60950-1, 2nd Edition, 2007-03-27 (Information Technology Equipment - Safety - Part 1: General Requirements)<br>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.                                 |
| VCCI                 | Voluntary Control Council for Interface to cope with disturbance problems caused by personal computers or facsimile.   |
| RoHS Compliant       | Restriction of Hazardous Substance Directive   |
| WEEE                 | Directive on Waste Electrical and Electronic Equipment   |

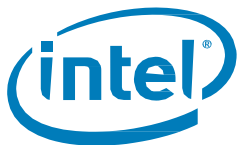




## Appendix A: IDENTIFY DEVICE Command Data

Table 17: Returned Sector Data

| Word  | F = Fixed<br>V = Variable<br>X = Both | Default Value                          | Description  |
|-------|---------------------------------------|--|--|
| 0     | X                                     | 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                                     | 8001h                                  | 7:0—Maximum number of sectors transferred per interrupt on multiple commands |
| 48    | F                                     | 4000h                                  | Trusted Computing Feature Set  |
| 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                                     | FC100FBh                               | Obsolete   |
| 59    | F                                     | B101                                   | Number of sectors transferred per interrupt on multiple commands             |
| 60-61 | V                                     | 1200GB: 0FFFFFFFh<br>1600GB: 0FFFFFFFh | Total number of user-addressable sector                                      |
| 62    | X                                     | 10000h                                 | Obsolete   |
| 63    | X                                     | 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                                     | 4030h                                  | Additional Supported   |
| 70    | F                                     | 0000h                                  | Reserved   |
| 71-74 | F                                     | 0h                                     | Reserved for IDENTIFY PACKET DEVICE command                                  |
| 75    | F                                     | 001Fh                                  | Queue depth  |
| 76    | F                                     | 850Eh                                  | Serial ATA capabilities  |



| Word    | F = Fixed<br>V = Variable<br>X = Both | Default Value                          | Description  |
|---------|---------------------------------------|--|--|
| 77      | F                                     | 0006h                                  | Reserved for future Serial ATA definition  |
| 78      | F                                     | 0040h                                  | Serial ATA features supported  |
| 79      | V                                     | 0040h                                  | Serial ATA features enabled  |
| 80      | F                                     | 03FCh                                  | Major version number   |
| 81      | F                                     | 0110h                                  | Minor version number   |
| 82      | F                                     | 746Bh                                  | Command set supported  |
| 83      | F                                     | 7501h                                  | Command sets supported   |
| 84      | F                                     | 6163h                                  | Command set/feature supported extension  |
| 85      | X                                     | 7469h                                  | Command set/feature enabled  |
| 86      | X                                     | B401h                                  | Command set/feature enabled  |
| 87      | X                                     | 6163h                                  | Command set/feature default  |
| 88      | X                                     | 407Fh                                  | Ultra DMA Modes  |
| 89      | F                                     | 0002h                                  | Time required for security erase unit completion   |
| 90      | F                                     | 0002h                                  | Time required for enhanced security erase completion   |
| 91      | V                                     | 0h                                     | Current advanced power management value  |
| 92      | V                                     | OFFFEh                                 | Master Password Revision Code  |
| 93      | X                                     | 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                                     | 1200GB: 8BBA0CB0h<br>1600GB: BA4D4AB0h | Maximum user LBA for 48-bit address feature set  |
| 104     | V                                     | 0h                                     | Streaming transfer time - PIO  |
| 105     | V                                     | 0006h                                  | Maximum number of 512-byte blocks of LBA Range Entries per DATA SET MANAGEMENT command                                     |
| 106     | F                                     | 6003h                                  | 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 worldwide name extension to 128 bits  |
| 116     | V                                     | 0h                                     | Reserved for technical report  |
| 117-118 | F                                     | 0h                                     | Words per logical sector   |
| 119     | F                                     | 405Ch                                  | Supported settings   |
| 120     | X                                     | 401Ch                                  | Command set/feature enabled/supported  |
| 121-126 | F                                     | 0h                                     | Reserved   |
| 127     | X                                     | 0h                                     | Removable Media Status Notification feature set support  |
| 128     | X                                     | 0029h                                  | Security status  |
| 129     | V                                     | 001Ch                                  | Vendor-specific  |
| 130-159 | X                                     | 0h                                     | Vendor-specific  |
| 160     | X                                     | 0h                                     | CompactFlash Association (CFA) power mode 1  |
| 161-167 | X                                     | 0h                                     | Reserved for assignment by the CFA   |



| Word    | F = Fixed<br>V = Variable<br>X = Both | Default Value | Description  |
|---------|---------------------------------------|---------------|--|
| 168     | X                                     | 0003h         | Reserved for assignment by the CFA   |
| 169     | X                                     | 0001h         | Data set management Trim attribute support   |
| 170-175 | F                                     | 0h            | Reserved for assignment by the CFA   |
| 176-205 | V                                     | Varies        | Current media serial number  |
| 206     | X                                     | 003Dh         | SCT Command Transport  |
| 207-208 | F                                     | 0000h         | Reserved   |
| 209     | X                                     | 4000h         | Alignment of logical blocks within a physical block                                |
| 210-211 | V                                     | 0000h         | Write-Read-Verify Sector Count Mode 3 (DWord)                                      |
| 212-213 | F                                     | 0000h         | Write-Read-Verify Sector Count Mode 2 (DWord)                                      |
| 214     | X                                     | 0000h         | NV Cache Capabilities  |
| 215-216 | V                                     | 0000h         | NV Cache Size in Logical Blocks (DWord)  |
| 217     | F                                     | 0001h         | Nominal media rotation rate  |
| 218     | V                                     | 0000h         | Reserved   |
| 219     | F                                     | 0000h         | NV Cache Options   |
| 220     | V                                     | 0000h         | Write-Read-Verify feature set  |
| 221     | X                                     | 0000h         | Reserved   |
| 222     | F                                     | 101Fh         | Transport major version number   |
| 223     | F                                     | 0000h         | Transport minor version number   |
| 224-229 | F                                     | 0000h         | Reserved   |
| 230-233 | X                                     | 0000h         | Extended Number of User Addressable Sectors (QWord)                                |
| 234     | F                                     | 0001h         | Minimum number of 512-byte data blocks per DOWNLOAD MICROCODE command for mode 03h |
| 235     | F                                     | FFFFh         | Maximum number of 512-byte data blocks per DOWNLOAD MICROCODE command for mode 03h |
| 236-254 | X                                     | 0000h         | Reserved   |
| 255     | V                                     | 46A5h         | 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.