# SanDisk® SSD X100

## Product Manual

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# Revision History

| Revision | Description | Date |
|---|---|---|
| 0.2 | • Initial version | Sep 15, 2011 |
| 0.3 | • Updated mSATA drawing<br>• Updated 64GB data<br>• Add 32GB mSATA configuration | Oct 25, 2011 |
| 0.4 | • Updated performance<br>• Added 2.5" 9.5mm configuration<br>• Updated word 106: 0x4000 | Nov 15, 2011 |
| 0.41 | • Updated mSATA drawing | Dec 1, 2011 |
| 0.5 | • Updated performance (2.3)<br>• Updated operating power consumption (3.4)<br>• Updated mSATA dimensions (tolerance) (4.3)<br>• Added mSATA drawing for keep out areas (4.3)<br>• Updated ESD test voltage (5.6)<br>• Updated chemical restrictions (5.9)<br>• Updated regulations (5.10)<br>• Added MTTF data (6.2)<br>• Updated Commands set (8.1)<br>• Updated Identify Data (8.2)<br>• Updated Log Pages (8.3)<br>• Updated Ordering information (9) | Dec 22, 2011 |
| 0.6 | • Updated performance (2.3)<br>• Updated power consumption (3.3 & 3.4)<br>• Updated operating power consumption (3.4)<br>• Updated mSATA form factor drawing (4.3)<br>• Updated mSATA thickness (4.3)<br>• Updated vibration (5.3)<br>• Updated shock (5.4)<br>• Updated MTTF of 512GB (6.2)<br>• Updated Identify Data (8.2)<br>• Removed Device Statistics (04h) from Log Pages (8.3) | Feb 29, 2012 |
| 0.7 | • Updated performance (2.3) | Apr 4, 2012 |
| 1.0 | • Updated performance (2.3)<br>• Average power consumption (3.3)<br>• Updated Identify Data (8.2), word 76 (HIPM enable) | Apr 19, 2012 |

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# 1. Introduction

## 1.1 General Description

SanDisk SSD X100 is designed to improve the mobile computing user experience with leading performance, high reliability and power efficiency in SATA standard 2.5" and mSATA small form factor.

SanDisk X100 with 32, 64, 128, 256 and 512 gigabyte[1] (GB) flash memory, support performance optimizations such as "Multi Stream" support, performance throttling, and move/copy mega-files in high performance.

With a state of the art and an evolutionary controller design, SanDisk SSD provides more than fast sequential read/write performance and provides significant improved random I/O performance and multi stream capabilities enabling SanDisk SSD to work much faster.

SanDisk, the industry leader in flash storage, is uniquely positioned to drive the paradigm shift in mobile computing to SSDs Inside enterprise and consumers computers, such as the thin & light laptops and transportable laptops.

This manual describes the functional, mechanical and interface specifications for the following SanDisk SSD X100 model drives: SATA 2.5" 7.0mm, SATA 2.5" 9.5mm and SATA mSATA.



[1] 1 megabyte (MB) = 1 million bytes; 1 gigabyte (GB) = 1 billion bytes. Some of the listed capacity is used for formatting and other functions, and thus is not available for data storage.

## 1.2 Key Features

- Flash Memory used:
  - SanDisk 24nm 64Gb MLC ABL
- Unformatted capacities[2]:
  - SATA 2.5”: 64GB, 128GB, 256GB, 512GB
  - mSATA: 32GB, 64GB, 128GB, 256GB
- Form factors:
  - SATA 2.5” 7.0mm case, complies with SFF-8223 and SFF-8201
  - SATA 2.5” 9.5mm case, complies with SFF-8223 and SFF-8201
  - Standard mSATA form factor with a Mini-PCIe edge connector, complies to JEDEC MO-300B standard
- Interface to host:
  - SATA 6Gb/s (Revision 3.0) compliant
  - Backwards compliant to SATA 3Gb/s & SATA 1.5Gb/s
  - ATA 8 Command Set ACS-2
  - NCQ support up to queue depth = 32
  - SMART support
- High performance[3]:
  - Maximum Host transfer rate: 6Gb/s
  - Sustained Sequential Read: 500 MB/s
  - Sustained Sequential Write: 430 MB/s
  - 4K Random Write: 43,000 IOPS
  - 4K Random Read: 76,000 IOPS
  - Write Latency: 65µs
  - Read Latency: 55µs
- Low power consumption:
  - Typical read/write[4]: 120mW to 150mW
  - Slumber power mode[5]: 70mW to 100mW

[2] The logical capacity of the drive conforms to the IDEMA HDD Specification. See www.idema.org for details. Some of the listed capacity is used for formatting and other functions, and thus is not available for data storage. 1 megabyte (MB) = 1 million bytes; 1 gigabyte (GB) = 1 billion bytes.

[3] Performance for 256GB product on SATA 6Gb/s host, Queue Depth = 32. Based on internal testing; performance may vary.

[4] Average (typical) power while running MobileMark™ 2007. X100 is configured with Device Initiated Power Management (DIPM) enabled and Host Initiated Power Management (HIPM) enabled. 120mW for form factors with input power of 3.3V ; 150mW for 2.5” standard SATA (5V).

[5] With DIPM enabled. 70mW-75mW for form factors with input power of 3.3V ; 100mW for 2.5” standard SATA (5V).

- Advanced Flash Management:
  - nCache™ – Non Volatile Write Cache
  - Support for TRIM
  - Dynamic & Static Wear-leveling
  - Bad Block Management
  - Background Garbage Collection

- Support for Dynamic Performance Throttling:
  - Performance will be throttled in the event junction temperature of critical components is measured to be exceeding the maximum allowable for the product.

- Highly-reliable:
  - At least 5 years useful life
  - Mean time to failure (MTTF): Up to 2,000,000 hrs
  - Uncorrectable Bit Error Rate (UBER): 1 sector per $10^{16}$ bits read
  - Operating and non-operating shock: 1,500G, 0.5ms half sine
  - Operating vibration: 5gRMS, 10-2000 Hz
  - Non-operating vibration: 4.9gRMS, 2.5-800 Hz
  - Operating temperature: 0˚C to 70˚C
  - Non-operating temperature and storage[6]: -55˚C to +85˚C



[6] Temperature measured on board via temperature sensor, Storage temperature does not guarantee data retention.

## 1.3 Functional Description

The SSD X100 contains a high-level, intelligent storage subsystem with powerful capabilities.

These capabilities include the following:

- Supports multi stream – improves user experience in multitasking systems
- Support for Trim command
- Minimal write amplification – increases endurance and performance
- Tiered caching – Volatile and non-volatile cache
- Supports ATA register and command set (ATA-8 / ACS2 standard)
- S.M.A.R.T. feature supported
- Host independence from details of erasing and programming flash memory
- Sophisticated system for error recovery including a powerful error correction code (ECC)
- Sophisticated system for managing defects
- Advanced power management for low power operation
- Implementation of dynamic and static wear-leveling to extend SSD X100 life

## 1.4 Advanced Flash Management

### 1.4.1 Defect and Error Management

SSD X100 contains a sophisticated defect and error management system that is similar to the systems found in magnetic disk drives, and in many cases, offers enhancements. If necessary, the SSD device will rewrite data from a defective block to a good block. This action is completely transparent to the host and does not consume any user data space.

The SSD soft error rate specification is much better than the magnetic disk drive specification. In the extremely rare case that a read error does occur, the SSD X100 products have innovative algorithms to recover the data by using error detection code and error correction code (EDC/ECC). These defect and error management systems, coupled with the solid state construction, give SSD X100 unparalleled reliability.

### 1.4.2 Wear Leveling

Wear leveling is an intrinsic part of the erase pooling functionality of SSDs using NAND memory. Advanced features of dynamic and static wear-leveling, and automatic block management are used to ensure an even distribution of write/erase cycles throughout the entire device, regardless of how dynamic or static the data written is. This guarantees high data reliability and maximizes flash life expectancy.

### 1.4.3 Bad Block Management

Bad blocks are occasionally created during the life cycle of a flash component, in a phenomenon called dynamic bad-block accumulation. These bad blocks must be marked and replaced dynamically in order to prevent read/write failures. When a bad block is detected, the embedded Bad Block Mapping algorithm maps out the block, which will remove the block from future use.

### 1.4.4 Tiered Caching

The SSD X100 supports a unique feature to improve random write performance and ensure very positive user experience. Studies show that modern operating systems mostly access the storage device using small access blocks, with the majority being 4KB access blocks.

The small logical access blocks conflict with the physical block structure (>1MB) for the newer generation flash memory technology. Therefore, to bridge this difference, SSD X100 employs three storage layers:

- Volatile cache - DDR DRAM cache
- nCache™ - A non-volatile flash write cache
- Mass storage – MLC NAND flash

The nCache™ is used to accumulate small writes (called segments) at high speed and then flush & consolidate them to larger MLC section of the NAND Flash memory array.

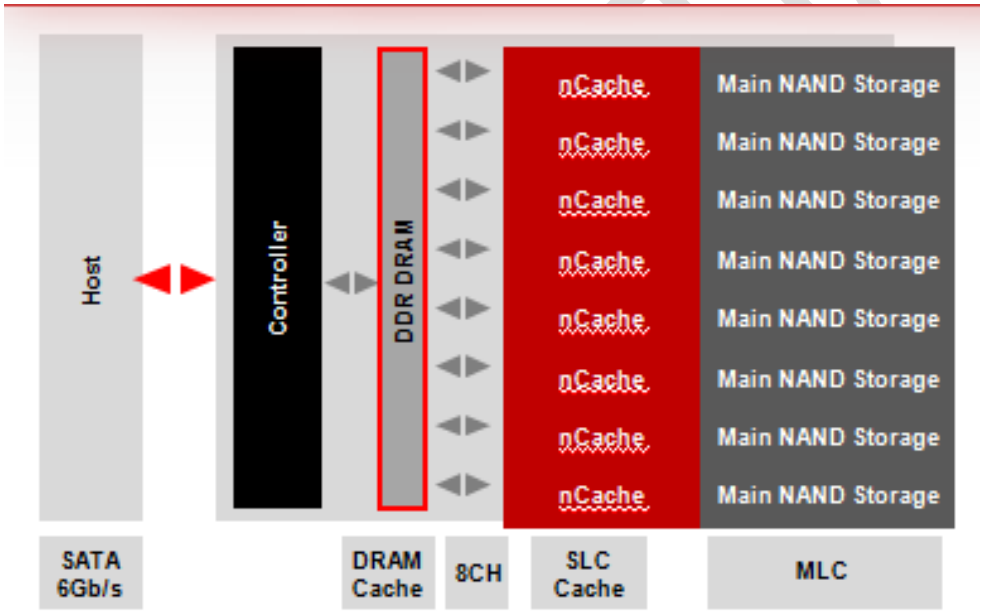


**Figure 1-1: SanDisk SSD X100 Tiered Caching Technology**

## 1.5 Advanced Power Management

SSD X100 supports an advanced power management system that includes both Host Initiated Power Management (HIPM) and Device Initiated Power Management (DIPM).

### 1.5.1 Slumber SATA low power mode

The SanDisk SSD x100 supports entering into Slumber SATA low power mode through DIPM (Device Initiated Power Management) as well as HIPM (Host Initiated Power Management). Upon completion of any command, in case of DIPM, the SSD will request the host to enter into Slumber power.

## 1.6 Background Garbage Collection

Once the SSD X100 detects idle time, the flash management firmware can utilize the time the device is idle in order to perform internal house-keeping operations. These internal house-keeping activities include freeing up the space in the nCache by flushing and consolidating to the MLC storage and rearranging the data in MLC array. Performing internal house-keeping activities in background will significantly improve performance of the device, providing swift user experience. These operations are executed internally and are transparent to the host. Any time a new command is received from the host the internal operations will be terminated and the host command will be serviced with minimal delay.

## 1.7 Performance Throttling

In order to protect the integrity of the data and prevent excessive heat dissipation, the SSD X100 utilizes an on-board/on-chip thermal sensor to monitor the SSD's critical component junction temperature. If the temperature rises above the allowable limit, the performance will be reduced until the temperature decreases to an allowable level. This performance throttling technique acts as a safety measure.

# 2. General Product Specifications

## 2.1 Interface

The SSD X100 interface complies with the Serial ATA standard published by ANSI. The device complies with the SATA 6Gb/s, Revision 3.0 specifications and supports ATA-8 Command Set ACS-2.

For more information, refer to the American National Standard X3.221: AT Attachment for Interface for Disk Drives document. Documentation can be ordered from IHS by calling 1-800-854-7179 or accessing their Web site: http://global.ihs.com

## 2.2 Capacity

| Unformatted Capacity[7] | Total Number of User-Addressable Sectors in LBA Mode[8] | Number of Logical Cylinders | Number of Logical Heads | Number of Logical Sectors per Track |
|---|---|---|---|---|
| 32GB | 62,533,296 | 16,383 | 16 | 63 |
| 64GB | 125,045,424 | 16,383 | 16 | 63 |
| 128GB | 250,069,680 | 16,383 | 16 | 63 |
| 256GB | 500,118,192 | 16,383 | 16 | 63 |
| 512GB | 1,000,215,216 | 16,383 | 16 | 63 |

**Table 2-1: SanDisk SSD X100 Capacity Specification**

[7] 1 gigabyte (GB) = 1 billion bytes. Some of the listed capacity is used for formatting and other functions, and thus is not available for data storage.

[8] 1 Sector = 512 bytes.

## 2.3 Performance[9]

| Parameter | Unit | NCQ | 32GB | 64GB | 128GB | 256GB | 512GB |
|---|---|---|---|---|---|---|---|
| **SATA 6Gb/s host interface** | | | | | | | |
| Sequential Read | MB/s | QD=32 | 295 | 495[10] | 500 | 500 | 480 |
| Sequential Write | MB/s | QD=32 | 95 | 190 | 355 | 430 | 410 |
| Random Read [4KB] | IOPs | QD=1 | 6,850 | 7,450 | 7,450 | 7,450 | 7,250 |
| | | QD=32 | 45,500 | 70,000[11] | 74,000 | 76,000 | 75,000 |
| Random Write [4KB] | IOPs | QD=1 | 19,500 | 21,000 | 21,000 | 21,000 | 21,000 |
| | | QD=32 | 21,500 | 34,000 | 38,000 | 43,000 | 42,500 |
| Read/Write Latency[12] | us | - | 55/65 | 55/65 | 55/65 | 55/65 | 55/65 |
| Typical power-on ready time[13] | Sec | - | 0.3 | 0.75[14] | 0.8 | 0.9 | 1 |

**Table 2-2: SanDisk SSD X100 Performance**

## 2.4 Endurance

| Parameter | 32GB | 64GB | 128GB | 256GB | 512GB |
|---|---|---|---|---|---|
| Long Term Data Endurance (LDE)[15] | >40TBW | >80TBW | >80TBW | >80TBW | >80TBW |

**Table 2-3: SanDisk SSD X100 Endurance**



[9] Measured using IOMETER 2006.07.27 on Intel® Core™ i7-2600 Processor based Windows7™PC, secondary drive configuration with host write cache enabled. Measurements are performed on 8GB of LBA range.

[10] 64GB: Sequential read 495MB/s for mSATA FF, 410MB/s for 2.5" FF

[11] 64GB: Random read 70,000 IOPs for mSATA FF, 67,000 IOPs for 2.5" FF

[12] Measured in sequential 4KB with QD=1

[13] Power on to Ready Time assumes Graceful Shutdown

[14] 64GB: Typical power-on ready time is 0.75 sec for mSATA FF and 0.3 sec for 2.5" FF

[15] LDE is calculated based on typical workload based on Windows OS. LDE is a direct function of user workload and access pattern. LDE is defined in terms of Terabytes Written, "TBW."

# 3. Power Characteristics

## 3.1 Supply Voltage

| Parameter | | Specifications |
|---|---|---|
| Input Voltage | **Form Factor** | |
| | Standard SATA connector | 5V ± 5% |
| | mSATA | 3.3V ± 5% |
| Maximum Ripple | | 100mV (peak to peak),<br>0 – 30MHz |
| Supply Rise Time | | 100msec |

**Table 3-1: SanDisk SSD X100 Supply Voltage**

## 3.2 Graceful Power-off Requirements

By default, most Operating Systems operate with Host Write Cache 'enabled,' which more accurately means there can be data residing in the X100 that hasn't been succesfully programmed into flash memory (this is a feature of ATA and not specific to SanDisk SSD products). To ensure this data is properly committed to flash memory, the X100 requires a Flush Cache command followed by a Standby Immediate command prior to power being removed. This command sequence allows the X100 to complete the programming of all data in its volatile data cache into flash memory, returning 'good' status to the host only after successful completion. This command sequence is handled transparently by most OS's during a standard shutdown sequence (e.g., hibernation, shutdown, standby, etc).

However, it is possible that in some applications (e.g., embedded systems without a typical user-interface providing graceful power-down options), power to the X100 could be removed, without warning, precluding the possibility of a graceful shutdown – resulting in the possibility of data loss and/or longer power on time.

## 3.3 Average Power Consumption[16]

Average power consumption is defined as the blended read/write/idle power used by the SSD X100 while it is operating with a typical OS installed. The power consumption is being measured while running MobileMark™ 2007 with Device Initiated Power Management (DIPM) enabled (allowing the SSD X100 to enter low power modes during host idle time). MobileMark™ 2007 simulates the usage of standard user applications in the Windows environment, providing a reproducible test platform for measuring average power consumption.

| Input Voltage | Parameter | 32GB | 64GB | 128GB | 256GB | 512GB |
|---|---|---|---|---|---|---|
| **SATA 6Gb/s host interface** | | | | | | |
| 5V ± 5% | Read/Write [mW] | NA | 150 | 150 | 150 | 150 |
| 3.3V ± 5% | Read/Write [mW] | 120 | 120 | 120 | 120 | NA |

**Table 3-2: SanDisk SSD X100 Average Power Consumption**



[16] Power measurements in 25 ° C. Based on FW version with HIPM-enable.

## 3.4 Operating Power Consumption – Average Max

Operating power consumption is measured while the X100 is continuously processing sequential read and write commands (tested separately) with a transfer size of 256 sectors per command (128KB). Sampling interval is 1 second. Measurement of operating power consumption is meant to demonstrate the worst-case continuous power required by the SSD X100 during long read or write command sequences.

| Input Voltage | Parameter | 32GB | 64GB | 128GB | 256GB | 512GB |
|---|---|---|---|---|---|---|
| **SATA 6Gb/s host interface** | | | | | | |
| 5V ± 5% | Read [mW] | NA | 2,250 | 2,700 | 2,700 | 2,700 |
| | Write [mW] | NA | 2,300 | 3,700 | 4,450 | 4,450 |
| 3.3V ± 5% | Read [mW] | 1,650 | 2,450 | 2,650 | 2,650 | NA |
| | Write [mW] | 1,450 | 2,050 | 3,400 | 4,200 | NA |

**Table 3-3: SanDisk SSD X100 Active Power Consumption**

## 3.5 Low Power Mode Consumption

Low power mode consumption is defined as the mode where the SSD X100 has entered Slumber mode (SATA PHY state) and DPDM (SSD X100 specific 'deep power down mode' that is entered after a period of IDLE where no ATA commands are received from the host).

| Input Voltage | Parameter | 32GB | 64GB | 128GB | 256GB | 512GB |
|---|---|---|---|---|---|---|
| **SATA 6Gb/s host interface** | | | | | | |
| 5V ± 5% | Slumber Mode [mW] | NA | 95 | 100 | 100 | TBD |
| 3.3V ± 5% | Slumber Mode [mW] | 70 | 75 | 75 | 75 | NA |

**Table 3-4: SanDisk SSD X100 Power Consumption in Low Power Mode**

# 4. Physical Specification

## 4.1 SATA 2.5” 7.0mm form factor

Complies with SFF-8201 & SFF-8223

| Parameter | Specifications |
|---|---|
| Width | 69.85mm |
| Length | 100.5mm |
| Thickness (max) | 7.0mm |
| Typical Weight | 66.5±1gr (64,128GB)<br>69.5±1gr (256,512GB) |

**Table 4-1: Mechanical Information – 2.5” 7.0mm Form Factor**

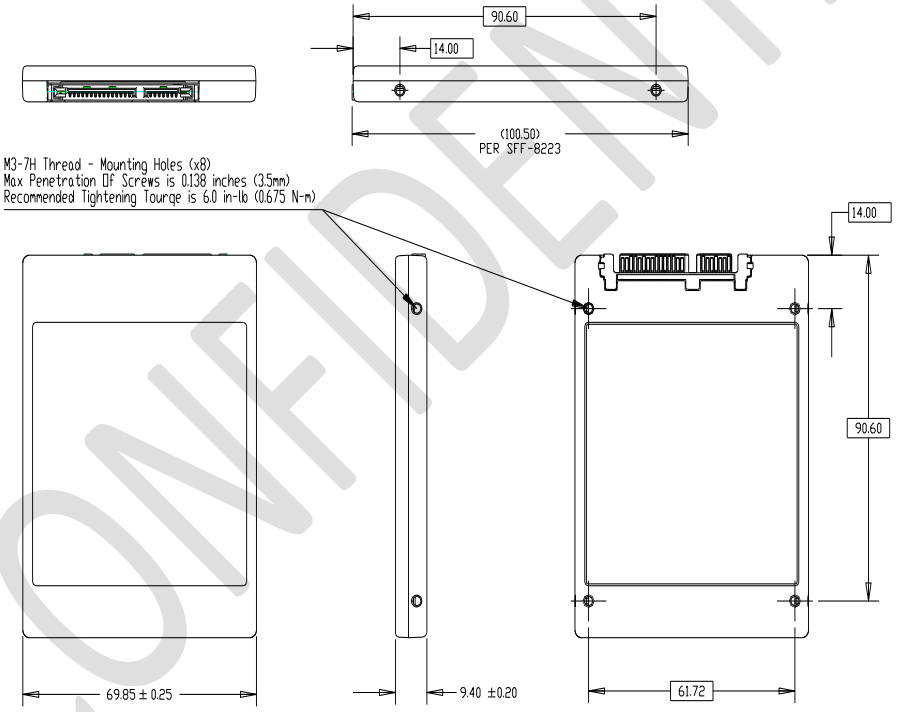


**Figure 4-1 : Drawing - 2.5” 7.0mm Form Factor**

## 4.2 SATA 2.5” 9.5mm form factor

Complies with SFF-8201 & SFF-8223

| Parameter | Specifications |
|---|---|
| Width | 69.85mm |
| Length | 100.5mm |
| Thickness (max) | 9.5mm |
| Typical Weight | 77±1gr (64,128GB)<br>81±1gr (256,512GB) |

**Table 4-2: Mechanical Information – 2.5” 9.5mm Form Factor**

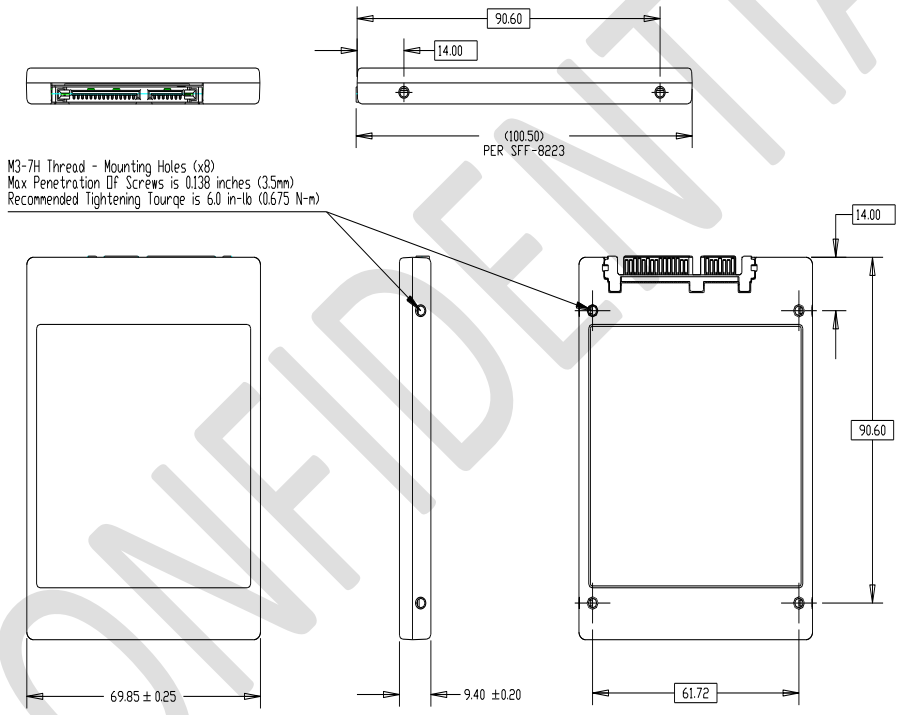


**Figure 4-2 : Drawing - 2.5” 9.5mm Form Factor**

## 4.3 mSATA Form Factor

Complies with MO-300B Standard

| Parameter | Specifications |
|---|---|
| Width | 29.85±0.15mm |
| Length | 50.80±0.15mm |
| Thickness (max) | 3.6mm |
| Typical Weight | 6.5±0.5gr (32,64GB)<br>7.5±0.5gr (128,256GB) |

**Table 4-3: Mechanical Information - mSATA form factor**

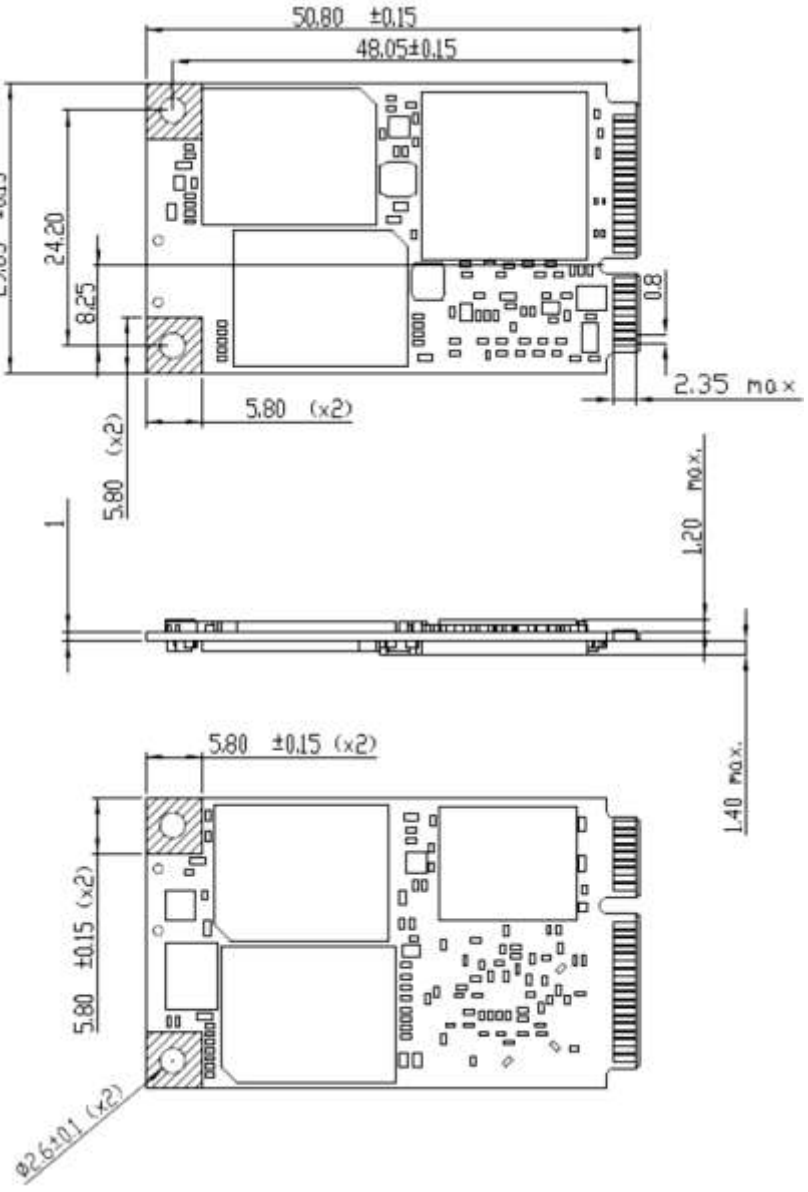


**Figure 4-3: Drawing - mSATA Form Factor**

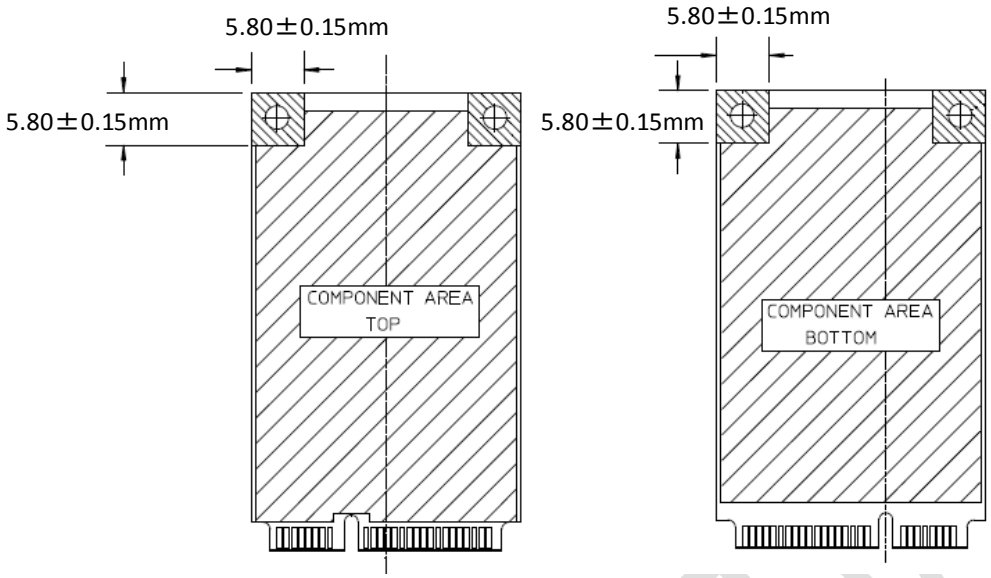


**Figure 4-4: Drawing - mSATA Keep Out Area**

# 5. Environmental Specifications

## 5.1 Temperature

| Parameter | Specifications |
|---|---|
| Operational[17] | 0°C to 70°C |
| Storage[18] | -55°C to 85°C |

**Table 5-1: SanDisk SSD X100 Temperature Specification**

## 5.2 Humidity

| Parameter | Specifications |
|---|---|
| **Operational** | |
| Humidity (Non condensation) | 5% to 95% |
| Maximum wet bulb | 30°C |
| **Non-operational** | |
| Humidity (Non condensation) | 5% to 95% |
| Maximum wet bulb | 40°C |

**Table 5-2: SanDisk SSD X100 Humidity Specification**

## 5.3 Vibration

| Parameter | Specifications |
|---|---|
| Non-operational | 4.9gRMS, 2.5-800 Hz, 3 axes |
| Operational | 5gRMS, 10-2000 Hz, 3 axes |

**Table 5-3: SanDisk SSD X100 Vibration Specification**

## 5.4 Shock

| Parameter | Acceleration Force | Half Sine pulse duration |
|---|---|---|
| Operational / Non operational | 1500G | 0.5ms |

**Table 5-4: SanDisk SSD X100 Shock Specification**

[17] Temperature for thermal operational is measured on board with X100 temperature sensor

[18] Storage temperature does not guarantee data retention

## 5.5 Altitude

| Parameter | Specifications |
|---|---|
| Operational / Non-Operational | -1500ft (-457m) to 40,000ft (12,192m) |

**Table 5-5: SanDisk SSD X100 Altitude Specification**

## 5.6 Electrostatic Discharge (ESD)

The SanDisk SSD X100 is ESD tested per IEC 61000-4-2 Standard.

| Parameter | Test Voltage |
|---|---|
| Contact | 4kV |
| Air | 8kV |

**Table 5-6: SanDisk SSD X100 ESD Specification**

## 5.7 Acoustics

The SSD X100 does not generate any acoustics noise (0dB).

## 5.8 EMI/RFI Compliance

The SanDisk SSD X100 is certified to comply with the following standards.

| Standard |
|---|
| FCC Part 15 Class B |
| IECS-003 Class B |
| EN 55022 Class B |
| EN 55024 |
| KCC No. 2008-39 |
| KCC No. 2008-38 |
| CNS 13438 |
| VCCI: 2006 |
| AS/NZS CISPR 22: 2006 |

**Table 5-7: SanDisk SSD X100 EMI/RFI Compliance**

## 5.9 Chemical Restrictions

SSD X100 complies with the European Union's Restriction on Use of Hazardous Substances in Electrical and Electronic Equipment (EU RoHS) Directive 2002/95/EC and its amendments European Union's Registration, Evaluation, Authorization and Restriction of Chemicals (REACH), Regulation (EC) 1907/2006.

SSD X100 complies with China's management methods for controlling pollution by electronic information products (China RoHS).

## 5.10 Regulations

The SanDisk SSD X100 is certified with the following certifications:

| Certification/Compliance | Description |
|---|---|
| UL certificated | UL 60950 US (UL) and UL Canadian (ULc) |
| CB certificated | EN 60950-1 |
| Technischer Überwachungsverein (TÜV) | EN 60950-1 |
| CE compliant | Conformity with essential health and safety requirements set in European directives of low voltage and EMC |
| Korea Communication Commission (KCC) | Conformity with Korean ministerial Ordinance |
| BSMI (Taiwan) | |
| VCCI (Japan) | Compliance with Voluntary Control Council for Interference by Information Technology Equipment (VCCI) |
| C-Tick (Australia) | Compliance with EMC framework requirements of Australian Communications Authority (ACA) |
| FCC | Compliance with FCC 47CFR part 15 subpart B class B |
| EU RoHS Directive [EU Directive 2002/95/EC] | |
| EU Packaging Directive [EU Directive 94/62/EC] | |
| EU WEEE Directive [EU Directive 2002/96/EC] | |
| EU REACH Regulation | |
| PFOS Directive [EU Directive 2006/122/EC] | |
| EU Directive 76/769/EEC | |
| China RoHS | EPuP (20) |

**Table 5-8: SanDisk SSD X100 Regulation Standards**

# 6. Reliability Characteristics

## 6.1 Error Rate

Non-recoverable error rate is 1 error per $10^{16}$ bits read.

## 6.2 MTTF (Mean-Time-To-Failure)

The reliability figure of merit most often used for electronic equipment is Mean-Time-To-Failure (MTTF). SanDisk estimates MTTF using a prediction methodology based in accordance with the Telcordia Special Report SR-332. The prediction is based on a Parts Stress Analysis.

Quality levels were defined as industrial grade (I) for all of the components. The detailed prediction for the system was performed at a temperature of 25°C in a GB environment.

The following table summarizes the estimated MTTF results for each capacity.

| Capacity | Condition | MTTF (Hours) |
|---|---|---|
| 32GB | Telcordia SR-332, GB, 25°C | 2,000,000 |
| 64GB | Telcordia SR-332, GB, 25°C | 2,000,000 |
| 128GB | Telcordia SR-332, GB, 25°C | 2,000,000 |
| 256GB | Telcordia SR-332, GB, 25°C | 2,000,000 |
| 512GB | Telcordia SR-332, GB, 25°C | 2,000,000 |

**Table 6-1: SanDisk SSD X100 MTTF**

# 7. Interface

## 7.1 Supported Standards

The SSD X100 complies with the following standards:

- SATA 6Gb/s, Revision 3.0
- ATA-8 Command Set ACS-2

## 7.2 Pin Assignments – Standard SATA

**SIGNAL Connector Pinout:**

| Pin # | Signal Name | Description |
|---|---|---|
| S1 | GND | 2nd mate |
| S2 | A+ | RxP |
| S3 | A- | RxM |
| S4 | GND | 2nd mate |
| S5 | B- | TxM |
| S6 | B+ | TxP |
| S7 | GND | 2nd mate |

**POWER Connector Pinout:**

| Pin # | Signal Name | Description |
|---|---|---|
| P1 | V33 | Not connected |
| P2 | V33 | Not connected |
| P3 | V33 | Not connected |
| P4 | GND | 1st mate |
| P5 | GND | 2nd mate |
| P6 | GND | 2nd mate |
| P7 | V5 | 5V power input, pre-charge, 2nd mate |
| P8 | V5 | 5V power input |
| P9 | V5 | 5V power input |
| P10 | GND | 2nd mate |
| P11 | DAS | Device Activity Signal |
| P12 | GND | 1st mate |
| P13 | V12 | Not connected |
| P14 | V12 | Not connected |
| P15 | V12 | Not connected |

**Table 7-1: Standard SATA Connector Pin Assignment**

## 7.3 Pin Assignments – mSATA

| Pin # | Assignment | Description | Pin # | Assignment | Description |
|---|---|---|---|---|---|
| 1 | | No Connect | 2 | +3.3V | 3.3V Source |
| 3 | | No Connect | 4 | GND | Return Current Path |
| 5 | | No Connect | 6 | | No Connect |
| 7 | | No Connect | 8 | | No Connect |
| 9 | GND | Return Current Path | 10 | | No Connect |
| 11 | | No Connect | 12 | | No Connect |
| 13 | | No Connect | 14 | | No Connect |
| 15 | GND | Return Current Path | 16 | | No Connect |
| 17 | | No Connect | 18 | GND | Return Current Path |
| 19 | | No Connect | 20 | | No Connect |
| 21 | GND | Return Current Path | 22 | | No Connect |
| 23 | +B - TXP | Transmitter Differential Signal Pair | 24 | +3.3V | 3.3V Source |
| 25 | -B - TXN | Transmitter Differential Signal Pair | 26 | GND | Return Current Path |
| 27 | GND | Return Current Path | 28 | | No Connect |
| 29 | GND | Return Current Path | 30 | | No Connect |
| 31 | -A - RXN | Receiver Differential Signal Pair | 32 | | No Connect |
| 33 | +A - RXP | Receiver Differential Signal Pair | 34 | GND | Return Current Path |
| 35 | GND | Return Current Path | 36 | | No Connect |
| 37 | GND | Return Current Path | 38 | | No Connect |
| 39 | +3.3V | 3.3V Source | 40 | GND | Return Current Path |
| 41 | +3.3V | 3.3V Source | 42 | | No Connect |
| 43 | | No Connect | 44 | | No Connect |
| 45 | | No Connect | 46 | | No Connect |
| 47 | | No Connect | 48 | | No Connect |
| 49 | DA/DSS | Device Activity | 50 | GND | Return Current Path |
| 51 | Presence Detection | Pulled low by device | 52 | +3.3V | 3.3V Source |

**Table 7-2: mSATA Connector Pin Assignment**

# 8. Supported ATA Commands

## 8.1 Commands set

The following table defines some of the common ATA commands supported by the SSD X100. Specifics of each ATA command's operation can be found in the ATA/ATAPI Command Set ACS-2 document.

| Command Name | | ATA8 | Code |
|---|---|---|---|
| Check Power Mode | | M | E5h |
| Data Set Management | | O | 06h |
| | Trim | | 01h |
| Device Configuration Overlay | | O | B1h |
| **DCO sub-commands:** | Restore | | C0h |
| | Freeze Lock | | C1h |
| | Identify | | C2h |
| | Set | | C3h |
| | Identify DMA | | C4h |
| | Set DMA | | C5h |
| Download Microcode | | O | 92h |
| | Download (without offsets) and save microcode. | | 07h |
| Execute Device Diagnostic | | M | 90h |
| Flush Cache | | M | E7h |
| Flush Cache Ext | | O | EAh |
| Identify Device | | M | Ech |
| Idle | | M | E3h |
| Idle Immediate | | M | E1h |
| Initialize Drive Parameters | | Obs | 91h |
| NOP | | O | 00h |
| Read Buffer | | O | E4h |
| Read DMA | | M | C8h |
| Read DMA Ext | | O | 25h |
| Read DMA w/o Retry | | Obs | C9h |
| Read FPDMA Queued | | O | 60h |
| Read Log Ext | | O | 2Fh |
| Read Multiple | | M | C4h |
| Read Multiple Ext | | O | 29h |

| | | | |
|---|---|---|---|
| Read Native Max Address | | O | F8h |
| Read Native Max Addr Ext | | O | 27h |
| Read Sectors | | M | 20h |
| Read Sectors Ext | | O | 24h |
| Read Sectors w/o Retry | | Obs | 21h |
| Read Verify Sectors | | M | 40h |
| Read Verify Sectors Ext | | O | 42h |
| Read Verify Sectors w/o Retry | | Obs | 41h |
| Recalibrate | | Obs | 1Xh |
| Security Disable Password | | O | F6h |
| Security Erase Prepare | | O | F3h |
| Security Erase Unit | | O | F4h |
| Security Freeze Lock | | O | F5h |
| Security Set Password | | O | F1h |
| Security Unlock | | O | F2h |
| Seek | | Obs | 7Xh |
| Set Features | | M | EFh |
| **Set Features sub-commands:** | Enable write cache | | 02h |
| | Set transfer mode | | 03h |
| | Enable Advanced Power Management (APM) | | 05h |
| | Enable SATA features | | 10h |
| | DMA Setup FIS Auto-Activate Optimization | | 02h |
| | Device-Initiated Interface Power Management | | 03h |
| | Software Setting Preservation | | 06h |
| | Disable read look-ahead | | 55h |
| | Disable reverting to power-on defaults | | 66h |
| | Disable write cache | | 82h |
| | Disable Advanced Power Management (APM) | | 85h |
| | Disable SATA features | | 90h |
| | DMA Setup FIS Auto-Activate Optimization | | 02h |
| | Device-Initiated Interface Power Management | | 03h |
| | Software Setting Preservation | | 06h |
| | Enable read look-ahead | | AAh |
| | Enable reverting to power-on defaults | | CCh |
| Set Max Address | | O | F9h |

| | | | | |
|---|---|---|---|---|
| **Security Extension sub-commands:** | Set Max Set Password | | | 01h |
| | Set Max Lock | | | 02h |
| | Set Max Unlock | | | 03h |
| | Set Max Freeze Lock | | | 04h |
| | Set Max Set Password DMA | | | 05h |
| | Set Max Unlock DMA | | | 06h |
| Set Max Address Ext | | | O | 37h |
| Set Multiple Mode | | | M | C6h |
| Sleep | | | M | E6h |
| Smart | | | O | B0h |
| **Smart sub-commands:** | Read Attribute Values (Read Data) | | | D0h |
| | Read Attribute Thresholds | | Obs | D1h |
| | Enable/Disable Attribute Autosave | | O | D2h |
| | Save Attribute Values | | | D3h |
| | **Execute Offline Immediate:** | | | D4h |
| | | Execute off-line immediate routine | | 00h |
| | | Execute Short Self-test routine (Offline) | | 01h |
| | | Execute Extended Self-test routine (Offline) | | 02h |
| | | Abort off-line immediate routine | | 7Fh |
| | | Execute Short Self-test routine (Captive) | | 81h |
| | | Execute Extended Self-test routine (Captive) | | 82h |
| | Read Log | | | D5h |
| | Write Log | | | D6h |
| | Enable Operations | | | D8h |
| | Disable Operations | | | D9h |
| | Read Status | | | DAh |
| | Enable/Disable Automatic Offline | | Obs | DBh |
| Standby | | | M | E2h |
| Standby Immediate | | | M | E0h |
| Write Buffer | | | O | E8h |
| Write DMA | | | M | CAh |
| Write DMA Ext | | | O | 35h |
| Write DMA w/o Retry | | | Obs | CBh |
| Write FPDMA Queued | | | O | 61h |
| Write Log Ext | | | O | 3Fh |

| | | | |
|---|---|---|---|
| Write Multiple | | M | C5h |
| Write Multiple Ext | | O | 39h |
| Write Sectors | | M | 30h |
| Write Sectors Ext | | O | 34h |
| Write Sectors w/o Retry | | Obs | 31h |
| Write Uncorrectable Ext | | O | 45h |
| | Pseudo-UECC with Logging | | 55h |

M = Mandatory. O = Optional. Obs = Obsolete, But Supported

**Table 8-1: Supported ATA Commands**

## 8.2 Identify Data

The following table defines the specifics of the Identify Data returned by the SSD X100.

| Word Address | Default Value | Total Bytes | Data Field Type Information |
|---|---|---|---|
| 0 | 0040h | 2 | ATA General configuration: bit-significant information |
| 1 | 3FFFh | 2 | ATA Default number of cylinders (depends on capacity) |
| 2 | C837h | 2 | Reserved |
| 3 | 0010h | 2 | Default number of heads |
| 4-5 | 0000h | 4 | Obsolete |
| 6 | 003Fh | 2 | Default number of sectors per track |
| 7-9 | 0000h | 6 | Obsolete |
| 10-19 | ASCII | 20 | Serial number in ASCII (left-justified) |
| 20-22 | 0000h | 6 | Obsolete |
| 23-26 | MJ.MN.XX | 8 | Firmware revision in ASCII (left-justified) |
| 27-46 | SanDisk SD5SX2XXXG | 40 | Model number in ASCII (left-justified) for SSD X00.<br>SKU without dash; X depends on capacity and form factor. |
| 47 | 8001h | 2 | Maximum No. of sectors in Read/Write Multiple command |
| 48 | 4000h | 2 | Trusted Computing feature set is not supported |
| 49 | 2F00h | 2 | LBA and MWDMA modes supported |
| 50 | 4000h | 2 | Capabilities |
| 51 | 0200h | 2 | PIO data transfer cycle timing mode |
| 52 | 0000h | 2 | Obsolete |
| 53 | 0007h | 2 | Field validity |
| 54 | 3FFFh | 2 | Current number of cylinders |
| 55 | 0010h | 2 | Current number of heads |
| 56 | 003Fh | 2 | Current sectors per track |
| 57-58 | XXXXh | 4 | Current capacity in sectors (LBAs) |
| 59 | 0101h | 2 | Multiple sector setting is valid (Multiple = 1) |
| 60-61 | XXXXh | 4 | Total number of sectors addressable in LBA Mode |
| 62 | 0000h | 2 | Obsolete |
| 63 | 0007h | 2 | Bits:15-8: Multiword DMA mode active<br>Bits: 0-7: Multiword DMA modes supported |
| 64 | 0003h | 2 | Advanced PIO modes supported |
| 65 | 0078h | 2 | Minimum multiword DMA transfer cycle time per word (ns) |

| Word Address | Default Value | Total Bytes | Data Field Type Information |
|---|---|---|---|
| 66 | 0078h | 2 | Recommended multiword DMA transfer cycle time per word in ns |
| 67 | 0078h | 2 | Minimum PIO transfer without flow control |
| 68 | 0078h | 2 | Minimum PIO transfer with IORDY flow control |
| 69 | 4020h | 2 | ATA8-ACS2 Additional Supported |
| 70-74 | 0000h | 10 | Reserved |
| 75 | 001Fh | 2 | Queue Depth |
| 76 | 870Eh | 2 | SATA capabilities |
| 77 | 0006h | 2 | SATA Additional capabilities (0002=1.5Gb/s, 0004=3Gb/s, 0006=6Gb/s) |
| 78 | 004Ch | 2 | SATA Features Supported |
| 79 | 0040h | 2 | SATA Features Enabled |
| 80 | 01F0h | 2 | Major Version number |
| 81 | 0028h | 2 | Minor Version number |
| 82 | 346Bh | 2 | Command set supported |
| 83 | 7D09h | 2 | Command sets supported |
| 84 | 4123h | 2 | Command set/feature supported extension |
| 85 | 3469h | 2 | Command set/feature enabled |
| 86 | BC09h | 2 | Command set/feature enabled |
| 87 | 4123h | 2 | Command set/feature default |
| 88 | 207Fh | 2 | Ultra DMA Mode supported and selected |
| 89 | 0001h | 2 | Time required for security erase-unit completion (all capacities complete < 2 minutes) |
| 90 | 0001h | 2 | Time required for Enhanced security erase completion |
| 91 | 0080h | 2 | Current advanced power management value |
| 92 | FFFEh | 2 | Master Password Identifier |
| 93 | 0000h | 2 | Hardware Reset Result |
| 94 | 0000h | 2 | Current AAM Value |
| 95 | 0000h | 2 | Stream Min Request Size |
| 96 | 0000h | 2 | Streaming Transfer Time-DMA |
| 97 | 0000h | 2 | Streaming Access Latency |
| 98-99 | 0000h | 4 | Streaming Performance Granularity |
| 100-103 | XXXXh | 8 | 48-bit # of LBA's |

| Word Address | Default Value | Total Bytes | Data Field Type Information |
|---|---|---|---|
| 104 | 0000h | 2 | Streaming Transfer Time-PIO |
| 105 | 0010h | 2 | Max # 512-byte Blocks in LBA Range Entries |
| 106 | 4000h | 2 | Physical Sector Size/Logical |
| 107 | 0000h | 2 | Inter-Seek Delay for ISO7779 |
| 108-111 | 5001B44XXXXXXXXXh | 8 | WWN |
| 112-115 | 0000h | 8 | Reserved |
| 116 | 0000h | 2 | Reserved for TLC |
| 117-118 | 0000h | 4 | Logical Sector Size |
| 119 | 400Ch | 2 | Command/Feature Sets Supported |
| 120 | 400Ch | 2 | Command/Feature Sets Enabled |
| 121-126 | 0000h | 12 | Reserved |
| 127 | 0000h | 2 | Obsolete |
| 128 | 0021h | 2 | Security Status |
| 129-159 | 0000h | 62 | Reserved vendor-unique bytes |
| 160-167 | 0000h | 16 | Reserved |
| 168 | 0003h/0005h | 2 | Device Nominal Form Factor 2.5”/module |
| 169 | 0001h | 2 | ATA8-ACS2 Data Set Management Support |
| 170-175 | 0000h | 12 | Reserved |
| 176-205 | 2020h | 60 | Current Media Serial Number (not supported) |
| 206 | 0000h | 2 | SCT Command Transport |
| 207-208 | 0000h | 4 | Reserved for CE-ATA |
| 209 | 4000h | 2 | Alignment-Logical within Physical Block |
| 210-211 | 0000h | 4 | Wr/Rd/Vfy Sector Count Mode 3 |
| 212-213 | 0000h | 4 | Wr/Rd/Vfy Sector Count Mode 2 |
| 214 | 0000h | 2 | NV Cache Capabilities |
| 215-216 | 0000h | 4 | NV Cache Size in Logical Blocks |
| 217 | 0001h | 2 | Nominal Media Rotation Rate |
| 218 | 0000h | 2 | Reserved |
| 219 | 0000h | 2 | NV Cache Options |

| Word Address | Default Value | Total Bytes | Data Field Type Information |
|---|---|---|---|
| 220 | 0000h | 2 | Wr/Rd/Vfy Feature Set-Current Mode |
| 221 | 0000h | 2 | Reserved |
| 222 | 103Fh | 2 | Transport Major Version Number |
| 223 | 0000h | 2 | Transport Minor Version Number |
| 224-233 | 0000h | 20 | Reserved for CE-ATA |
| 234 | 0000h | 2 | Min Sector Count for Download Microcode Mode 3 |
| 235 | 0000h | 2 | Max Sector Count for Download Microcode Mode 3 |
| 236-254 | 0000h | 38 | Reserved for CE-ATA |
| 255 | XXXXh | 2 | Integrity Word-Checksum |

**Table 8-2: Identify Data Values**

## 8.3 Log Pages

The following table defines the list of supported Log Pages accessible through SMART Write Log, SMART Read Log, Read Log Ext and Write Log Ext commands.

| Log Address | Total Pages | Log Address Description | Access |
|---|---|---|---|
| 00h | 1 | General Purpose Log Directory | GPL, SMART Log |
| 01h | 1 | Summary SMART Error Log | SMART Log |
| 02h | 2 | Comprehensive SMART Error log | SMART Log |
| 03h | 1 | Extended Comprehensive SMART Error Log | GPL |
| 06h | 1 | SMART Self-Test Log | SMART Log |
| 07h | 1 | Extended SMART Self-Test log | GPL |
| 10h | 1 | NCQ Error Log | GPL |
| 11h | 1 | SATA PHY Event Counters Log | GPL |
| 80-9Fh | 16 | Host Vendor-specific Logs | GPL, SMART Log |

**Table 8-3: Supported SMART Log Pages**

# 9. Ordering information

| SD5SXP-CCCU-YYYYT | |
|---|---|
| SD | SanDisk |
| 5 | Generation: 5 |
| S | SATA |
| X | Form factor:<br>B – 2.5” 7.0mm cased form factor<br>C – 2.5” 9.5mm cased form factor<br>F – mSATA form factor |
| P | 2 – MLC |
| CCC | Capacity:<br>032<br>064<br>128<br>256<br>512 |
| U | Units:<br>G – GB |
| YYYY | Customer code reference |
| T | NAND Technology:<br>E - 24nm MLC ABL |

**Table 9-1: SSD X100 Ordering Information**

Refer to the examples below as reference for ordering SKUs.

| **SKU #** | **Details** |
|---|---|
| SD5SB2-256G | SSD X100 256GB in 7.0mm cased form factor |
| SD5SF2-032G | SSD X100 32GB in mSATA form factor |

**Table 9-2: Examples of decoded SKU for SSD X100 Products**

# 10. Contact information

USA
Tel: +1-408-470-4440
Fax: +1-408-470-4470
OEMinfo@sandisk.com

China
Tel: +86-755-8348-5218
Fax: +86-755-8348-5418
OEMChina@sandisk.com

Taiwan
Tel: +886-2-2515-2522
Fax: +886-2-2515-2295
OEMAsia@sandisk.com

Korea
Tel: +82-2-3452-9079
Fax: +82-2-3452-9145

Japan
Tel: +81-3-5423-8101
Fax: +81-3-5423-8102
OEMJapan@sandisk.com

Europe
Tel: +33-(1)-43-37-2131
Fax: +33-(1)-43-37-2111
OEMEurope@sandisk.com

Rest of the World & Israel
Tel: +972-9-764-5000
Fax: +972-3-548-8666

For more information, please visit www.sandisk.com/SSD