# SanDisk®

# SSD SATA 5000 2.5"

## Product Manual

Preliminary, Rev 0.7

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# Table of Contents

# 1.    Introduction

## 1.1   *General Description*

SanDisk SSD SATA 5000 2.5" is designed to drive the shift of mobile PC users and blade server users from the hard disk drive to the solid state drive (SSD). A drop-in replacement for the hard disk drive, it delivers far superior durability, performance and power efficiency ─ keeping mobile PCs and blade servers working optimally in the toughest of conditions.

SanDisk SSD SATA 5000 2.5" (SanDisk SSD), with 8, 16, 32 and 64 gigabyte[1] (GB) flash memory, is targeted at enterprise users as the first step in mass consumer adoption of the SSD in the mobile PC market.

With no moving parts, SanDisk SSD does not need to spin up into action or to seek files in the way that conventional hard disk drives do ─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 computers, such as the thin & light laptops and transportable laptops; SanDisk SSD delivers unbeatable durability, system performance and power efficiency.

This manual describes the functional, mechanical and interface specifications for the following SanDisk SSD 5000 model drives:

- SDS5C-064G-000010
- SDS5C-032G-000010
- SDS5C-016G-000010
- SDS5C-008G-000010

- SDS5C-064G-0000E0
- SDS5C-032G-0000E0
- SDS5C-016G-0000E0
- SDS5C-008G-0000E0

## 1.2   *Key Features*

High capacity in small form factor

- o   2.5" small form factor, supporting unformatted capacity of 8, 16, 32, 64GB
- o   9.5mm case height
- o   SATA 7+15 pins combo connector

Interface to host

- o   Standards: SATA 1.0a 1.5Gb/s

High performance

- o   Host transfer rate: 150MB/s

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[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.

- o   Internal transfer read rate: 68MB/s

- o   Internal transfer write rate: 60MB/s

- o   Random Read (4KB): 4800 IOPS

- o   Average access time: 0.11msec

Low power consumption

- o   Supply voltage: 5Vdc

- o   Typical read: 180mA

- o   Typical write: 190mA

- o   Typical idle: 110mA

- o   Typical standby: 70mA

Highly reliable

- o   Mean time to failure (MTTF): 2,000,000 hours, based on Part Stress Analysis

- o   Operating shock: 1,500G, 0.5msec half sine

- o   Operating vibration: 16.3gRMS, 10-2000 Hz

- o   Operating temperature:

  - o   Commercial:  0˚C to 70˚C

  - o   Enhanced: -25˚C to 75˚C

- o   Non-operating temperature and storage: -55˚C to 95˚C
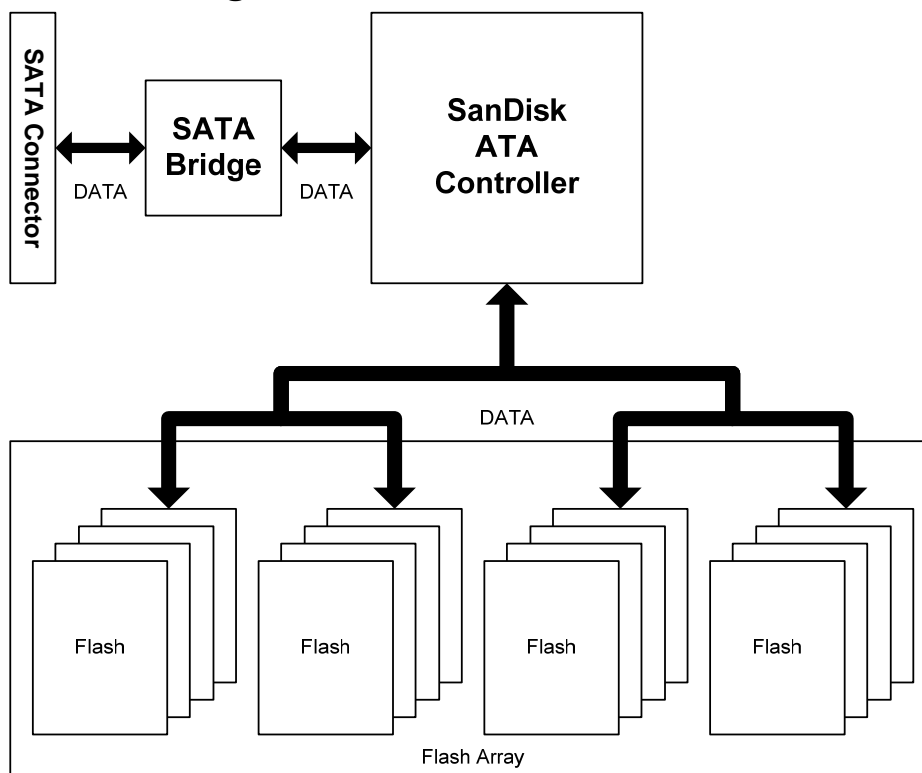
## 1.3   *Block Diagram*



*Figure 1: SanDisk SSD SATA 5000 2.5" Block Diagram*

# 2.    General Product Specifications

## 2.1   *Interface*

The SSD interface complies with the following standards:

SATA 1.0a Gen1i (1.5Gb/s)

SATA 2.5

ATA-7

The SSD supports Serial ATA 1.5Gbps (150MB/sec) interface rate.

## 2.2   *Capacity*

This datasheet refer to the 8, 16, 32, 64GB version.

### Table 1: SanDisk SSD SATA 5000 2.5″ Capacity

| Unformatted Capacity | Total Number of User-Addressable Sectors in LBA Mode | Number of Logical Cylinders | Number of Logical Heads | Number of Logical Sectors per Track |
|---|---|---|---|---|
| 8GB | 15,649,200 | 15,311 | 16 | 63 |
| 16GB | 31,277,232 | 16,383 | 16 | 63 |
| 32GB | 62,533,296 | 16,383 | 16 | 63 |
| 64GB | 125,045,424 | 16,383 | 16 | 63 |

## 2.3   *Performance*

### Table 2: SanDisk SSD SATA 5000 2.5″ Performance

| Parameter | Specifications |
|---|---|
| Host transfer rate: | |
|    Ultra DMA mode[1] | 150MB/s |
| Internal transfer rate (maximum): | |
|    Sequential Read[1,2] | 68MB/s |
|    Sequential Write[1,2,6] | 60MB/s |
|    Random Read[1,3] | 68MB/s |
|    Random Write[1,3] | 6MB/s |
| IOPS: | |
|    Random Read (4KB)[1,3] | 4800 |
|    Random Write (4KB)[1,3] | 10 |
| Average access time[1,2,4] | 0.11 msec |
| Typical power-on ready time[5] | 1.0 sec |

1.    Tested in Ultra DMA 150MB/s
2.    H2BENCH.c,v 3.6 2002/10/31, Windows 32-bit
3.    IOMETER 2003.12.16
4.    SSD does not have seek time or latency time
5.    Assume proper shutdown process.
6.    Write Buffer of 32KB is used to optimize small transfer size transactions.

# 3.    Power Characteristics

## 3.1   *Supply Voltage*

*Table 3: SanDisk SSD SATA 5000 2.5″ Supply Voltage*

| Parameter | Specifications |
|-----------|----------------|
| Input Voltage | 5V ± 5% |
| Maximum Ripple | 100mV (peak to peak), 0 − 30MHz |
| Supply Rise Time | 7 msec to 100 msec |
| Maximum Supply Fall Time | 5 sec |

## 3.2   *Power Consumption*

*Table 4: SanDisk SSD SATA 5000 2.5″ Power Consumption*

| Parameter | Specifications (W) |
|-----------|--------------------|
| Maximum | 1.1 |
| Read (Typical) | 0.9 |
| Write (Typical) | 0.95 |
| Active Idle (Typical) | 0.55 |
| Idle (Typical) | 0.45 |
| Standby (Typical) | 0.34 |
| Sleep (Typical) | 0.31 |

## 3.3   *Power Consumption Efficiency*

*Table 5: SanDisk SSD SATA 5000 2.5″ Power Consumption Efficiency (Watts/GB) [1]*

| Capacity (GB) | Specifications (W) |
|---------------|--------------------|
| 8 | 0.0562 |
| 16 | 0.0281 |
| 32 | 0.0140 |
| 64 | 0.0070[2] |

1.    Power consumption efficiency is calculated as Power Consumption Idle (watts)/Capacity (GB)
2.    Preliminary

# 4.    Physical Characteristics

## 4.1  *Mechanical*

*Table 6: SanDisk SSD SATA 5000 2.5″ Mechanical Dimensions and Weight*

| Parameter | Specifications |
|-----------|----------------|
| Width | 69.85 ± 0.25 mm |
| Height | 9.5 ± 0.2 mm |
| Length | 102.0 ± 0.25 mm |
| Maximum Weight | 96 gr |

## 4.2  *Mounting Instructions*

Before unpacking and installing the drive, take anti-static measures in order to avoid damage to the drive. The drive may be exposed to potential handling and electrostatic discharge (ESD) hazards. The following guidelines are recommended:

Keep the drive in ESD bag until the drive is ready to be installed.

Wear an ESD-proof wrist strap when handling the drive.

Avoid touching the drive's connector. Handle the drive using its edge or frame.

Rest the drive on an antistatic surface until mounting it.

Handle the drive carefully, taking care not to drop or bang it against other objects.

Do not remove, damage or cover any product labels. Removal of such labels voids the warranty.

The ambient temperature at the top cover should not exceed the maximum operating temperature of the drive.

Exercise caution when removing the drive from the host as the drive may have heated up.

The recommended mounting screw torque is 0.675Nm.

The recommended mounting screw depth is 4.0mm (0.157in) for bottom for horizontal mounting.

## 4.3  *Installation Orientation*

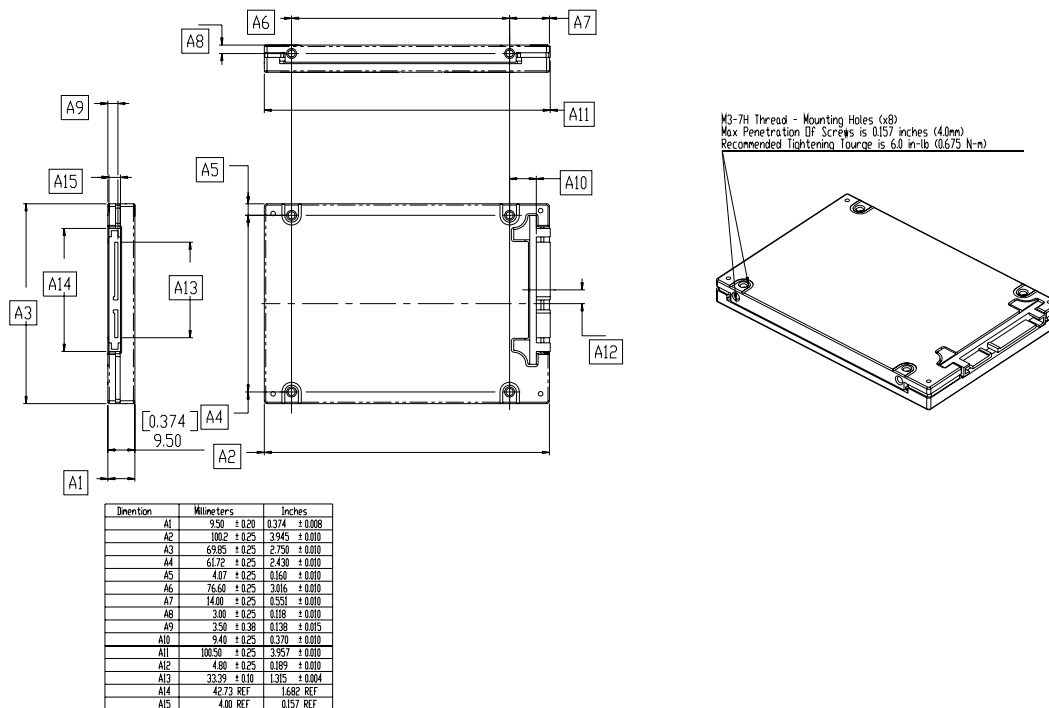The SSD can be installed in all axes (6 directions). For a mechanical drawing, see Figure 2.



| Dimention | Millimeters | | Inches | |
|---|---|---|---|---|
| A1 | 9.50 | ± 0.20 | 0.374 | ± 0.008 |
| A2 | 100.2 | ± 0.25 | 3.945 | ± 0.010 |
| A3 | 69.85 | ± 0.25 | 2.750 | ± 0.010 |
| A4 | 61.72 | ± 0.25 | 2.430 | ± 0.010 |
| A5 | 4.07 | ± 0.25 | 0.160 | ± 0.010 |
| A6 | 76.60 | ± 0.25 | 3.016 | ± 0.010 |
| A7 | 14.00 | ± 0.25 | 0.551 | ± 0.010 |
| A8 | 3.00 | ± 0.25 | 0.118 | ± 0.010 |
| A9 | 3.50 | ± 0.38 | 0.138 | ± 0.015 |
| A10 | 9.40 | ± 0.25 | 0.370 | ± 0.010 |
| A11 | 100.50 | ± 0.25 | 3.957 | ± 0.010 |
| A12 | 4.80 | ± 0.25 | 0.189 | ± 0.010 |
| A13 | 33.39 | ± 0.10 | 1.315 | ± 0.004 |
| A14 | 42.73 REF | | 1.682 REF | |
| A15 | 4.00 REF | | 0.157 REF | |

*Figure 2: SanDisk SSD SATA 5000 2.5″ Mechanical Drawing*

# 5.    Environmental Specifications

## 5.1  *Temperature*

*Table 7: SanDisk SSD SATA 5000 2.5" Temperature Support*

| Parameter | Specifications |
|---|---|
| Operating: | |
| Commercial Version | 0°C to 70°C |
| Enhanced Version | -25°C to 75°C |
| Non-operating | -55°C to 95°C |
| Storage | -55°C to 95°C |
| Maximum temperature gradient | 30°C per hour |

## 5.2  *Humidity*

*Table 8: SanDisk SSD SATA 5000 2.5" Humidity Support*

| Parameter | Specifications |
|---|---|
| Operating | |
| Humidity (Non condensation) | 5% to 95% |
| Maximum web bulb | 29°C |
| Non-operating | |
| Humidity (Non condensation) | 5% to 95% |
| Maximum web bulb | 38°C |
| Maximum relative humidity gradient | 20% per hour |

## 5.3  *Vibration*

*Table 9: SanDisk SSD SATA 5000 2.5" Vibration Support*

| Parameter | Specifications |
|---|---|
| Operating | 16.3 gRMS, 10 – 2000Hz |

## 5.4  *Shock*

*Table 10: SanDisk SSD SATA 5000 2.5" Shock Support*

| Parameter | Acceleration Force (G) | Half-sine Pulse Duration (msec) |
|---|---|---|
| Operating | 500 | 2 |
| | 1,500 | 1 |
| | 1,500 | 0.5 |
| Non-operating | 200 | 10 |
| | 1,500 | 1 |
| | 1,500 | 0.5 |

## 5.5 *Altitude*

### *Table 11: SanDisk SSD SATA 5000 2.5" Altitude Support*

| Parameter | Specifications |
|---|---|
| Operating | -400m to 24,384m<br>(-1,312ft. to 80,000ft.) |
| Non-operating | -400m to 24,384m<br>(-1,312ft. to 80,000ft.) |

## 5.6 *Acoustics*

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

## 5.7 *Regulations*

The SSD is certified with the following standards.

### *Table 12: SanDisk SSD SATA 5000 2.5" Regulation Standards*

| Standard | Details |
|---|---|
| Underwriters Laboratories (UL) | UL 60950-1 |
| UL Canadian (ULc) | CAN/CSA C22.2 No. 60950-1-03 (UL 60950) |
| Technischer Überwachungsverein (TÜV) | EN 60950:2000 |
| Ministry of Information and Communication (MIC) | CISPR Pub. 22 Class B |
| Bureau of Standards, Metrology and Inspection (BSMI) | CNS 13438:2006, Class B |
| Australian Communications Authority (ACA) | AS/NZS CISPR 22:2002, Class B |
| Voluntary Control Council for Interference by Information Technology Equipment (VCCI) | R-1113 and C-1172, Class B[1] |

1. This is a Class B product based on the standard of the Voluntary Control Council for Interference by Information Technology Equipment (VCCI). If this equipment is used in a domestic environment, it may cause radio interference. Install and use the equipment according to the instruction manual.

### 5.7.1   *EMC*

Directive 73/23/ECC for product safety

Directive 89/336/EEC:

***Table 13: SanDisk SSD SATA 5000 2.5″ Electromagnetic Compatibility Support***

| Parameter | Standard |
|---|---|
| Emission | EN55022:1998, A1:2000,A2:2003 |
| | IEC 61000-3-3 |
| Immunity | EN55024:1998, A1:2001, A2:2003 |
| | IEC 61000-4-2 |
| | IEC 61000-4-3 |
| | IEC 61000-4-4 |
| | IEC 61000-4-5 |
| | IEC 61000-4-6 |
| | IEC 61000-4-8 |
| | IEC 61000-4-11 |

### 5.7.2   *FCC*

FCC 47CFR part 15 subpart B class B.

## 5.8   *RoHS*

Directive of the European Parliament and of the Council on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment, 2002/95/EC, January 2003. (RoHS Directive).

# 6.    Reliability Characteristics

## 6.1  *Error Rate*

The non-recoverable error rate is 1 error per $10^{14}$ bits read.

## 6.2  *Product Life*

The product life is at least 5 years or 43,800 power-on hours, whichever comes earlier, under the following conditions:

Power-on hours = 8,760 per year

Operating time = 100% of power-on hours

Active/Idle duty cycle = 90% of the time

Environmental = temperature, altitude, humidity and voltage within operating ranges

The drive should be protected from electrostatic discharge (ESD)

o    The product life does not represent any warranty or warranty period. Applicable warranty and warranty period are covered by the purchasing agreement.

Note: Product life is defined as time in service at systems conditions while maintaining compliance to the MTTF specification for the device.

Applicable warranty and warranty period are covered by the purchase agreement.

## 6.3  *Mean Time to Failure*

Mean Time to failure (MTTF) is calculated based on part stress analysis.

The following conditions are set for calculation:

Ambient temperature = 25°C

*Table 14: SanDisk SSD SATA 5000 2.5″ MTTF*

| Capacity (GB) | MTTF (hours) |
|---|---|
| 8, 16, 32, 64 | 2,000,000 |

## 6.4  *Preventive Maintenance*

No preventive maintenance is required.

# 7. Interface

## 7.1 *Supported Standards*

The SSD complies with the following standards:

ATA/ATAPI-7: ANSI INCITS 397-2005, AT Attachment with Packet Interface-7.

Serial ATA Revision 2.5 Specification (Ratification Date: October 27, 2005).

## 7.2 *Interface Connector Characteristics*

**Table 15: SanDisk SSD SATA 5000 2.5" Connector Characteristics**

| Parameter | Specifications |
|---|---|
| Drive Connector | FCI, 10039651-001LF |
| Mating/Unmating force | The force to mate a receptacle connector and compatible plug connector should not exceed 45N (4.6kgf)<br>The unmating force should not be less than 10N (1.0kgf) |
| Durability | 5,000 cycles |

## 7.3 *Hotplug Support*

The SSD supports hotplug operation per SATA 2.5 specification.

## 7.4 *SATA Bridge Support*

The SSD supports Marvell's Serial ATA bridge (P/N: 88SA8040).
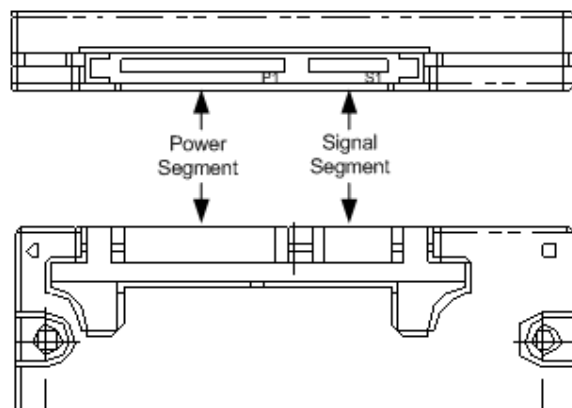
## 7.5 *Interface Connector Drawing*



**Figure 3: Interface Connector View**

## 7.6 *Pin Assignment*

### *Table 16: SanDisk SSD SATA 5000 2.5" Pin Assignment*

| | Pin | Function | Description |
|---|---|---|---|
| **Signal Segment** | S1 | Ground | 2$^{nd}$ mate |
| | S2 | A+ | Differential Signal Pair A |
| | S3 | A- | |
| | S4 | Ground | 2$^{nd}$ mate |
| | S5 | B- | Differential Signal Pair A |
| | S6 | B+ | |
| | S7 | Ground | 2$^{nd}$ mate |
| **Power Segment** | P1 | $V_{33}$ | 3.3V Power |
| | P2 | $V_{33}$ | 3.3V Power |
| | P3 | $V_{33}$ | 3.3V Power, Pre-charge, 2$^{nd}$ Mate |
| | P4 | Ground | 1$^{st}$ Mate |
| | P5 | Ground | 2$^{nd}$ Mate |
| | P6 | Ground | 2$^{nd}$ Mate |
| | P7 | $V_5$ | 5V Power, Pre-charge, 2$^{nd}$ Mate |
| | P8 | $V_5$ | 5V Power |
| | P9 | $V_5$ | 5V Power |
| | P10 | Ground | 2$^{nd}$ Mate |
| | P11 | DAS | Device Activity Signal |
| | | | The corresponding pin to be mated with P11 in the power cable receptacle connector shall always be grounded. |
| | P12 | Ground | 1$^{st}$ Mate |
| | P13 | $V_{12}$ | 12V Power, Pre-charge, 2$^{nd}$ Mate |
| | P14 | $V_{12}$ | 12V Power |
| | P15 | $V_{12}$ | 12V Power |

1. All pins are in a single row, with a 1.27 mm (0.050") pitch.

# 8. Supported ATA Commands

| Command Name | | Command Code |
|---|---|---|
| ATA standard commands | | |
| Download Microcode | | 92h |
| Execute Device Diagnostic | | 90h |
| Flush Cache | | E7h |
| Flush Cache Ext | | EAh |
| Identify Device | | ECh |
| Device Configuration Restore | | B1h/C0h |
| Device Configuration Freeze lock | | B1h/C1h |
| Device Configuration Identify | | B1h/C2h |
| Device Configuration Set | | B1h/C3h |
| Identify Device DMA | | EEh |
| Initialize Device Parameters | | 91h |
| NOP | | 00h |
| Read Buffer | | E4h |
| Read DMA | | C8h or C9h |
| Read DMA Extended | | 25h |
| Read Multiple | | C4h |
| Read Multiple Extended | | 29h |
| Read Sectors | | 20h or 21h |
| Read Sectors Extended | | 24h |
| Read Verify Sectors | | 40h or 41h |
| Read Verify Sectors Extended | | 42h |
| Read Native Max Address | | F8h |
| Read Native Max Address Ext | | 27h |
| Set Max Address | | F9h |
| Set Max Address Extended | | 37h |
| Recalibrate | | 10h |
| Seek | | 70h |
| Read Log Ext | | 2Fh |
| Write Log Ext | | 3Fh |
| Set Features | | EFh |
| **Set Features sub-commands:** | Enable write cache (default: On) | 02h |
| | Set transfer mode | 03h |
| | Enable Advanced Power Management | 05h |
| | Enable SATA Feature - software Setting Preservation | 10h |
| | Enable automatic acoustic management | 42h |
| | Disable look-ahead | 55h |
| | Disable reverting to power-on defaults | 66h |

| | | |
|---|---|---|
| | Disable write cache | 82h |
| | Disable Advanced Power Management | 85h |
| | Enable SATA Feature- software Setting Preservation | 90h |
| | Enable look-ahead | AAh |
| | Disable automatic acoustic management | C2h |
| | Enable reverting to power-on defaults | CCh |
| S.M.A.R.T Read Data | | B0h/D0h |
| S.M.A.R.T Read Attribute Thresholds | | B0h/D1h |
| S.M.A.R.T Enable Disable Attribute Autosave | | B0h /D2h |
| S.M.A.R.T Save Attribute Values | | B0h /D3h |
| S.M.A.R.T Execute Offline Immediate | | B0h /D4h |
| S.M.A.R.T Read Log | | B0h /D5h |
| S.M.A.R.T Write Log | | B0h /D6h |
| S.M.A.R.T Enable Operations | | B0h /D8h |
| S.M.A.R.T Disable Operations | | B0h /D9h |
| S.M.A.R.T Return Status | | B0h /DAh |
| S.M.A.R.T Disable automatic offline | | B0h /DBh |
| Set Multiple Mode | | C6h |
| Write Buffer | | E8h |
| Write DMA | | CAh |
| Write DMA Extended | | 35h |
| Write Multiple | | C5h |
| Write Multiple Extended | | 39h |
| Write Sectors | | 30h or 31h |
| Write Sectors Extended | | 34h |
| Write Verify | | 3Ch |
| **ATA standard Security commands** | | |
| Security Disable Password | | F6h |
| Security Erase Prepare | | F3h |
| Security Erase Unit | | F4h |
| Security Freeze Lock | | F5h |
| Security Set Password | | F1h |
| Security Unlock | | F2h |
| **ATA standard power management commands** | | |
| Check Power Mode | | 98h or E5h |
| Idle | | 97h or E3h |
| Idle Immediate | | 95h or E1h |
| Sleep | | 99h or E6h |
| Standby | | 96h or E2h |
| Standby Immediate | | 94h or E0h |

## 8.1  *Troubleshooting*

## 8.2  *Basic Checks*

Most disk problems are caused by improper disk installation. If a problem arises, the following should be checked:

Cable:

- o   Improper cable has been used
- o   Cables are too long to support the transfer rate
- o   Improper cable connection to the device

Device connector: Improperly locked

Power supply: Below SSD requirements

## 8.3  *BIOS Setup*

Verify that the disk is enabled in the BIOS. In most new BIOSs, there is an option for drive auto-identification.

## 8.4  *Slow Drive Performance*

Poor disk performance may be due to one of the following:

Check that Write Caching is enabled in the drive under the category Properties.

# 9. Ordering Information

*Table 17: SanDisk SSD SATA 5000 2.5″ Ordering Information*

| SDIGF-CCCU-XXXXGY | |
|---|---|
| SD | SanDisk |
| I | Interface: <br> S – SATA |
| G | Generation: <br> 5 – 5000 (5$^{th}$) |
| F | Form factor: <br> C – 2.5" (9.5mm) |
| CCC | Capacity (GB): <br> 008 <br> 016 <br> 032 <br> 064 |
| U | Units: <br> G (GB) |
| XXXX | Customer code reference |
| G | Component generation <br> 0 – Initial generation, Commercial Temperature. <br> 1 - first generation, Commercial Temperature <br> E - first generation, Enhanced Temperature Support (-25˚C to 75˚C) |
| Y | Change code |

Example:

SanDisk SSD SATA 5000 2.5″ 64GB: SDS5C-064G-000010

<u>Revision History</u>
February 2007     Preliminary Rev 0.1 – 1$^{st}$ release
May 2007              Rev 0.2 – 2$^{nd}$ release (containing preliminary info on 64GB)
July 2008              Rev 0.7 – (Containing preliminary information)