SSD P4 Solid State Drive

Product Manual

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Revision History

Revision	Description	Date
0.1	• Initial draft	May 20, 2010
0.2	• Major document format changes • Updated LDE values • Update performance values • Updated power consumption values • Added SanDisk SSD P4 block diagram • Added Standard SATA with large screw hole size form factor mechanical specification & ordering information • Updated Ordering information (decoder keys)	July 15, 2010
0.3	• Added 4GB capacity data • Updated Reliability & MTTF numbers	August 9, 2010
0.4	• Added details of 2.5”/7mm cased SSD P4 form-factor	August 27, 2010
0.5	• Update MTTF numbers for 4GB and 128GB capacities. • Update Identify Data table: o Word 69 – Changed Trim support from Deterministic to non-Deterministic. o Word 83 – Set correct bit to indicate SET MAX Security Extension Supported. o Word 105 – Indicate support for 1 sector of LBA Range Entries (Trim).	September 27, 2010
1.0	• Updated 4GB power consumption numbers. • Removed “Preliminary” document status.	October 6, 2010
1.1	• Update Identify Data table: o Word 77 now reports the SATA Phy speed per the SATA 3.0 specification. • Added support of “Enhanced Mode” Security Erase Unit command (words 90 and 128).	October 28, 2010

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1. Introduction

1.1 General Description

The SanDisk® SSD P4 builds on the momentum of the first and second generations of pSSD and the overall trend in the market towards smaller, thinner computing machines that enable mobility and connectivity on the go.
Using NAND flash based storage to replace Hard Disk Drives, SSD P4 provides a much improved user experience. In addition to being rugged and reliable, the third generation modular SSD beats HDDs in every possible metric – power consumption, sequential and random read performances as well as sequential and random write performances. The SATA interface aligns with the global transition in the industry, which is enforced by the platform's chipsets.

Using the advanced 32nm memory geometry provides for a low cost product which beats the HDDs price in the capacity ranges of 4GB-32GB and provides a very competitive product at capacities of 64GB and 128GB. In addition, the small form factor enables further miniaturization of **Netbooks, SmartBooks and Tablets** designs and opens doors for a whole range of other applications.

The SSD P4 product electrically complies with the SATA-II ver. 2.6 standards and is electrically compatible with a serial ATA disk drive.
In addition to the mass storage-specific NAND flash memory chips, the SSD includes an on-board intelligent controller for managing interface protocols, data storage and retrieval, error-correcting code (ECC), defect handling and diagnostics, advance power management and clock control. Using innovative data management algorithms, the SSD P4 provides superior sequential and random IO performance, and ensures data reliability.

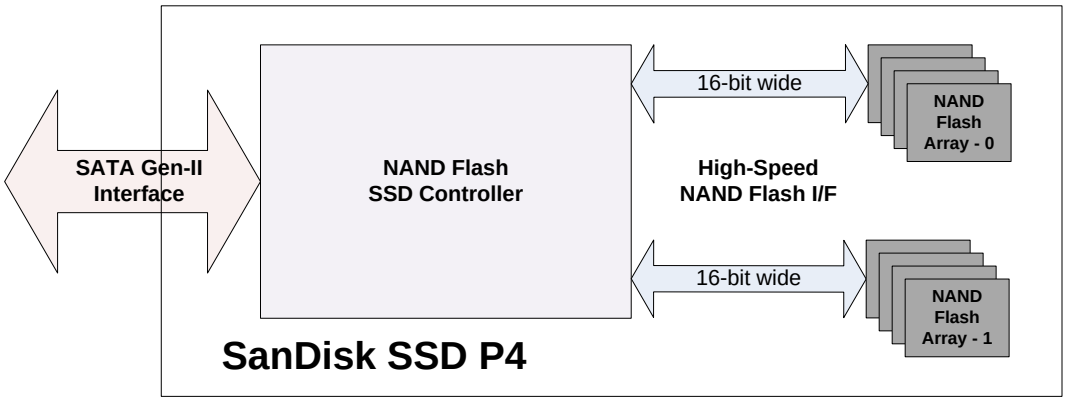

Figure 1-1: SanDisk SSD P4 Block Diagram

Unlike an HDD, the SSD P4 has no moving parts. It keeps working in environments such as classrooms, kiosks and in space-restricted server racks. The patented flash management technology brings top data integrity to the SSD, even during power losses. Dynamic bad block management, dynamic and static wear-leveling, and robust error detection and correction code (EDC/ECC) ensure data integrity.
Once the SSD has been configured by the host, it appears to the host as a standard ATA (IDE) disk drive.

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1.2 Key Features

High capacity, ultra-small form factor supporting unformatted capacities[1] of 4GB, 8GB, 16GB, 32GB, 64GB and 128GB:

- Half 1.8" with a 2.5" Standard SATA connector, complies to the Jedec-297 standard
- Half 1.8" with a micro SATA connector
- Standard mSATA form factor with a Mini-PCIe connector, complies to the Jedec MO-300A standard
- mSATA Mini form factor with a Mini-PCIe connector

Interface to host

- SATA II revision 2.6, 3.0Gbps

High performance[2]

- Host transfer rate: 300 MB/s
- Sustained Read: 160 MB/s
- Sustained Write: 100 MB/s
- 4K Random Write (Sustained): 135 IOPS
- 4K Random Write (Recovered): 690 IOPS
- 4K Random Read: 2200 IOPS

Low power consumption

- Typical read/write[3]: 0.18W
- Slumber mode: 60mW

Highly reliable

- Mean time to failure (MTTF): 4,530,805 hours, based on Part Stress Analysis
- Operating shock: 1,500G, 0.5msec half sine
- Operating vibration: 5gRMS, 10-2000 Hz
- Operating temperature: 0°C to 70°C
- Non-operating temperature and storage: -55°C to +85°C

[1] 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.

[2] These performance numbers refer to the 32GB product. Based on internal testing; performance may vary

[3] Average (typical) power while running MobileMark™ 2007 with Device Initiated Power Management (DIPM) enabled.

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1.3 Functional Description

SSD P4 contains a high level, intelligent subsystem. This intelligent (microprocessor) subsystem provides many capabilities not found in other types of memory cards. These capabilities include the following:

- Standard ATA register and command set
- Support for Trim command
- S.M.A.R.T. feature supported
- Host independence from details of erasing and programming flash memory
- Sophisticated system for managing defects (similar to systems found in magnetic disk drives)
- Sophisticated system for error recovery including a powerful error correction code (ECC)
- Advanced power management for low power operation
- Implementation of dynamic and static wear-leveling to extend card's life

1.4 Defect and Error Management

SSD P4 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 card will rewrite data from a defective sector to a good sector. 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 P4 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 P4 unparalleled reliability.

1.5 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 cycle throughout the entire device, regardless of how dynamic or static the data written is. This guarantees high data reliability and maximizes flash life expectancy.

1.6 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 be not used for storage anymore.

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1.7 Non-Volatile Write Cache

The third generation of modular SSD, the SSD P4 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 a 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 P4 employs a non-volatile SLC Flash write cache, nCache™. The nCache™ is used to accumulate these small writes (called segments) at high speed and then flush & consolidate them to larger MLC section of the NAND Flash memory array in the background during idle time.

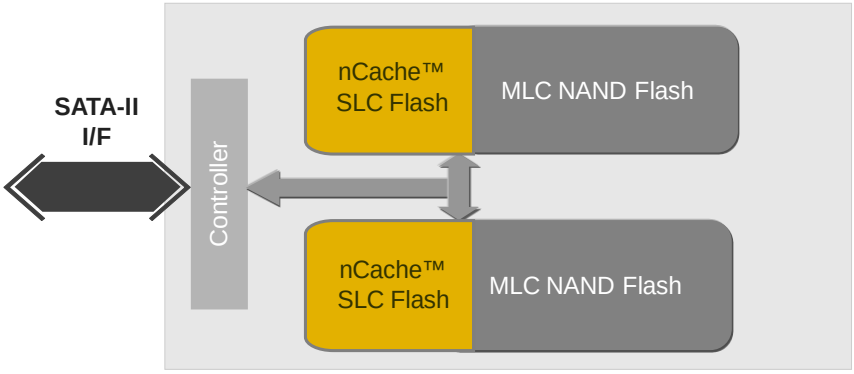

Figure 1-2: SanDisk SSD P4 nCache™ technology

The cache size of the SSD P4 is over 500MB[4] - an order of magnitude larger than other competing solutions that use DRAM based cache. Due to its large size, for most part of daily user activity nCache™ never overflows and the end users experience high SLC burst performance rather than the sustained performance. Once the nCache™ becomes full, the performance of SSD P4 drops to the steady state condition.
Also nCache™ is a non-volatile cache and hence there is no exposure to data loss[5].

1.8 Power Management

SSD P4 supports an advanced power management system that includes both Host Initiated Power Management (HIPM) and Device Initiated Power Management (DIPM).
Upon completion of a command, the SSD will ask the host to enter into Slumber Mode to conserve power if no further commands are received within 20msec. By directly entering Slumber mode and skipping partial mode will minimize power consumption. In order to further enhance the SSD performance, the flash management can utilize the time when the card is idle for performing internal house-keeping operations. Doing those activities, i.e. – freeing up space in the nCache, while the card is idle will not increase overall power consumption, since these operations will have to be executed eventually. Executing them during idle time will prevent stalling the host while they are taking place and will enable a better utilization of the Data Cache, as it will have additional free space when the host will

[4] The cache size scales with capacity. For 32GB product the cache size is over 500MB.

[5] In order to prevent any data loss during removal of the power supply (with Host Write Cache disabled), the time it takes the input voltage to drop from the nominal voltage down to 2V must be at least 5ms.

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access the device. These operations are executed internally, while the card is indicating status ready to the host. At the moment a new command is received from the host the internal operations will be terminated and the host command will be serviced with minimal delay. If no command is received the execution of the house-keeping activities will be limited to 30 seconds, to preserve power consumption.

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2. General Product Specifications

2.1 Interface

The SSD P4 interface complies with the Serial ATA standard published by ANSI. The device complies with the SATA II, ver. 2.6 specifications and supports ATA-8 ACS.
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[6]	Total Number of User-Addressable Sectors in LBA Mode[7]	Number of Logical Cylinders	Number of Logical Heads	Number of Logical Sectors per Track
4GB	7,835,183	7,772	16	63
8GB	15,649,200	15,525	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
128GB	250,069,680	16,383	16	63

Table 2-1: SanDisk SSD P4 Capacity Specification

[6] 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.

[7] 1 Sector = 512 bytes.

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2.3 Performance

Parameter	Unit	4GB	8GB	16GB	32GB	64GB	128GB
Host transfer rate							
SATA II, 3.0Gbps	MB/s	300	300	300	300	300	300
Transfer rates							
Sequential Read[8]	MB/s	60	130	140	160	160	160
Sequential Write	MB/s	12	25	50	100	100	100
Random Read [4KB][9]	IOPs	2600	2400	2300	2200	2200	2200
Random Write – Sustained [4KB]	IOPs	50	100	135	135	135	120
Random Write – Recovered [4KB]	IOPs	600	680	680	690	690	690
Typical power-on ready time	msec.	250 typical; 500 max	250 typical; 500 max	250 typical; 500 max	250 typical; 500 max	250 typical; 500 max	250 typical; 500 max

Table 2-2: SanDisk SSD P4 Performance

2.4 Endurance

Parameter	4GB	8GB	16GB	32GB	64GB	128GB
Long Term Data Endurance (LDE)[10]	2.5TBW	5TBW	10TBW	20TBW	40TBW	80TBW

Table 2-3: SanDisk SSD P4 Endurance

[8] Using HDBench on Windows7™ OS based PC as a secondary drive with host write cache enabled. File size of 100MB.

[9] Using IOMETER 2006.07.27 with host write cache enabled. The measurement is of 4KB aligned random accesses across 100% of the drive's capacity.

[10] 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."

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3. Power Characteristics

3.1 Supply Voltage

Parameter		Specifications
Input Voltage	**Form Factor**	
	Standard SATA connector	5V ± 5%
	Micro SATA connector	3.3V ± 5%
	mSATA / mSATA Mini	3.3V ± 5%
Maximum Ripple		70mV (peak to peak), 0 – 30MHz
Supply Rise Time		7 msec to 100 msec

Table 3-1: SanDisk SSD P4 Supply Voltage

3.2 Average Power Consumption[11]

Input Voltage	Parameter	4GB	8GB	16GB	32GB	64GB	128GB
5V ± 5%	Read/Write [mW]	170	180	180	200	200	200
3.3V ± 5%	Read/Write [mW]	140	140	140	175	175	175

Table 3-2: SanDisk SSD P4 Average Power Consumption

3.3 Active Power Consumption[12]

Input Voltage	Parameter	4GB	8GB	16GB	32GB	64GB	128GB
5V ± 5%	Read [mW]	475	500	550	700	725	725
	Write [mW]	500	600	900	1425	1450	1450
3.3V ± 5%	Read [mW]	375	450	500	650	650	650
	Write [mW]	400	500	850	1200	1400	1400

Table 3-3: SanDisk SSD P4 Active Power Consumption

[11] Average (typical) power while running MobileMark™ 2007 with Device Initiated Power Management (DIPM) enabled.

[12] Active power consumption is measured during long sequential (either read or write) operations.

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3.4 Low Power Mode Consumption

Input Voltage	Parameter	4GB	8GB	16GB	32GB	64GB	128GB
5V ± 5%	Partial / Slumber Mode [mW]	60	60	60	60	60	60
3.3V ± 5%	Partial / Slumber Mode [mW]	57	57	57	57	57	57

Table 3-4: SanDisk SSD P4 Power Consumption in Low Power Mode

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4. Physical Specification

4.1 Half 1.8" - Standard SATA Connector

Complies with SFF-8156/ MO-297 standards

Parameter	Specifications
Width	54mm
Length	39mm
Thickness (max)	3.08mm (4-64GB), 4.38mm (128GB) Connector 4.00mm
Typical Weight	6.4g (8-32GB), 7.4g (64GB), 8.7g (128GB)

Table 4-1: Mechanical Information - Standard SATA form factor

4.1.1 Standard SATA 4GB-64GB capacity

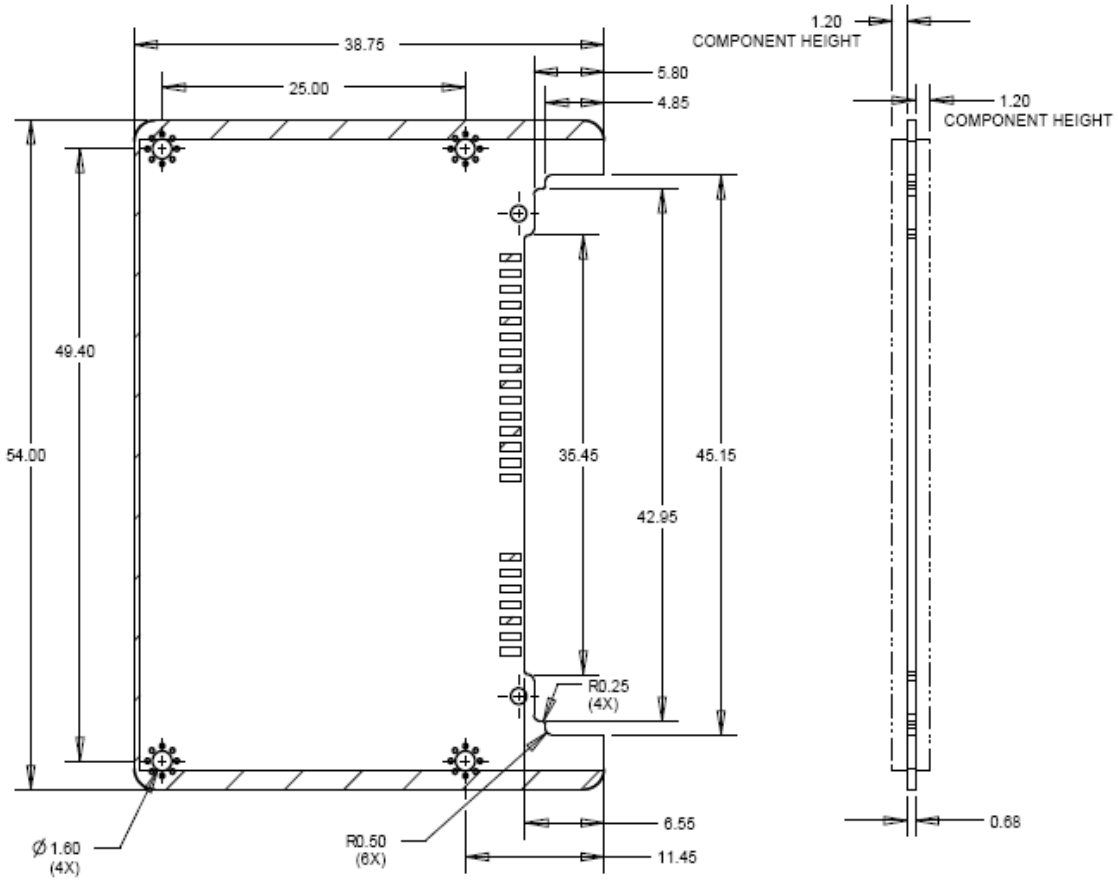

Figure 4-1: Standard SATA 4GB-64GB Top and Side view with keep out area

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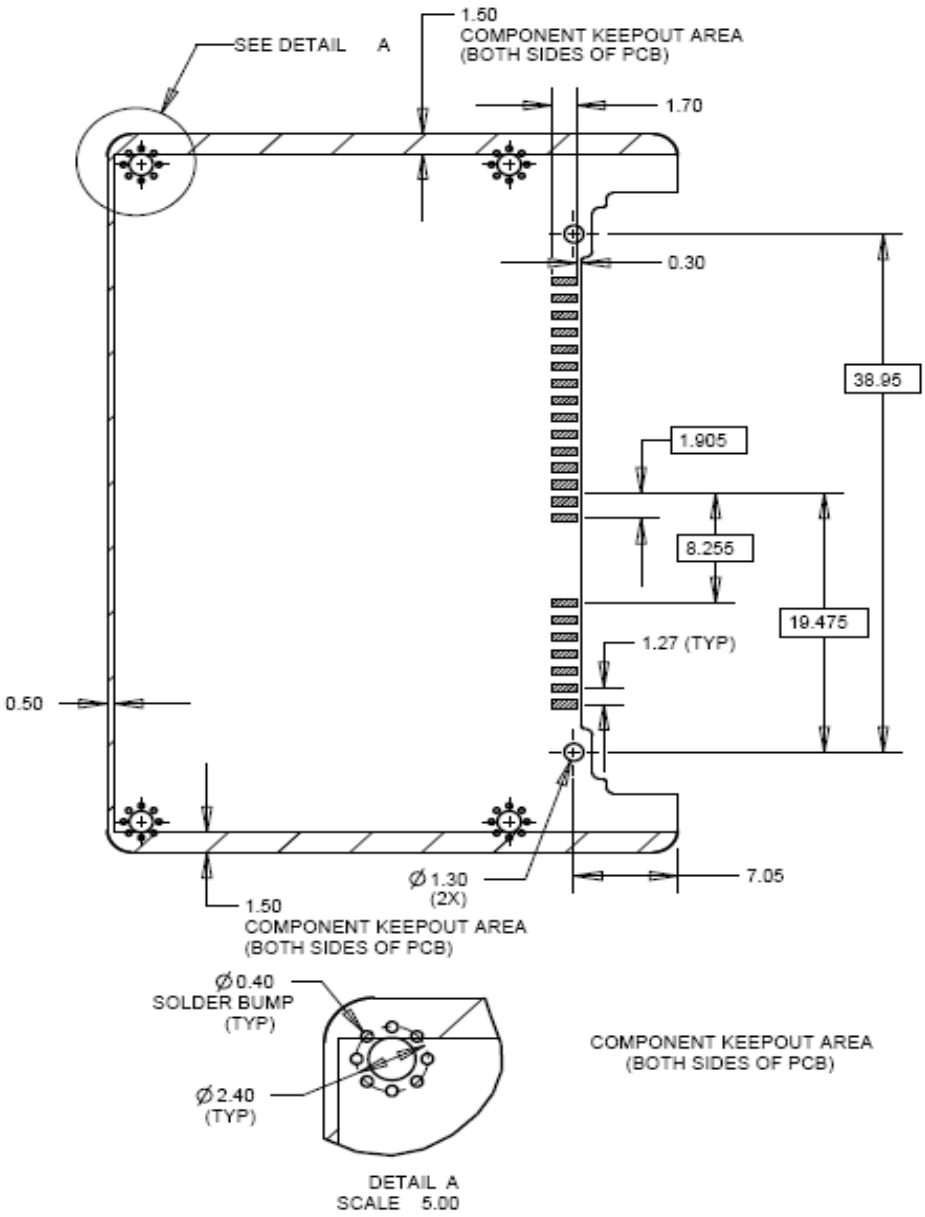

Figure 4-2: Standard SATA 4GB-64GB Top/Bottom View with more details

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4.1.2 Standard SATA 128GB capacity

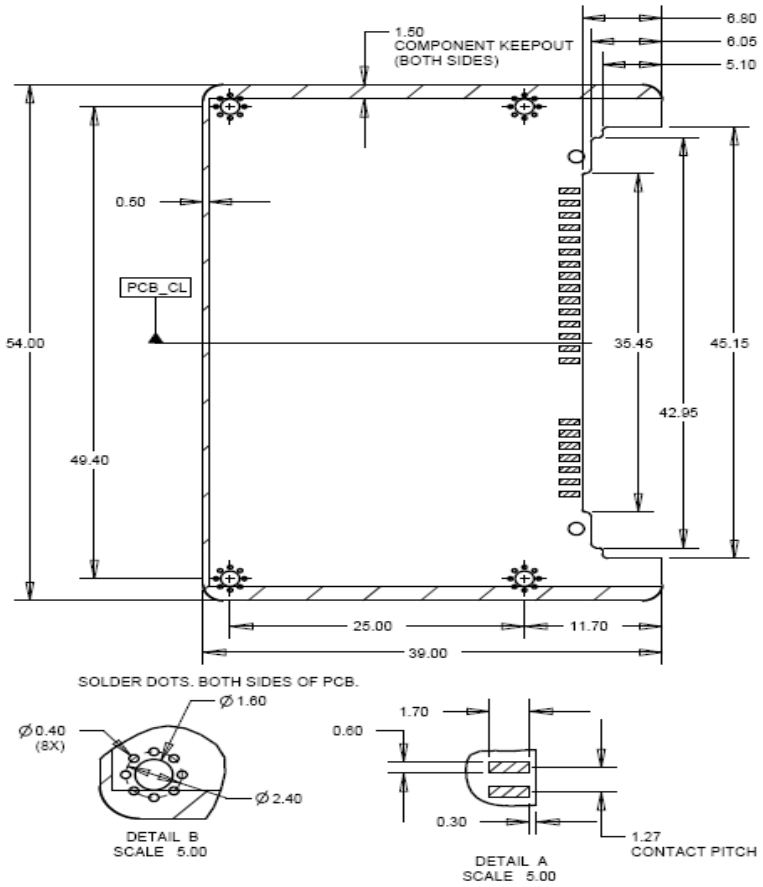

Figure 4-3: Standard SATA 128GB Top/Bottom view with keep out area

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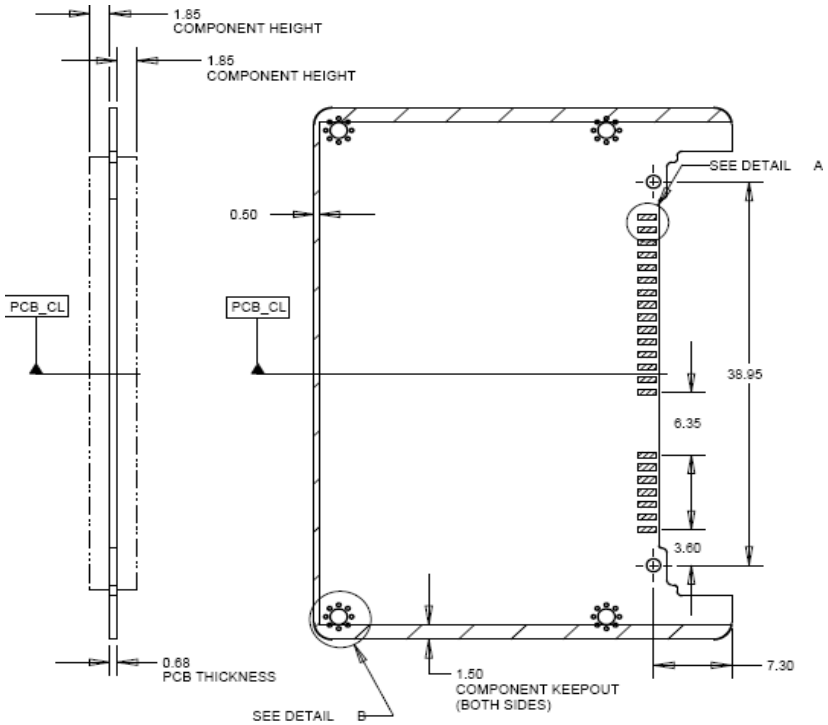

Figure 4-4: Standard SATA 128GB Top view with more details and Side view

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4.1.3 Standard SATA with large screw hole size

Parameter	Specifications
Width	54mm
Length	38.75mm
Thickness (max)	3.08mm Connector 4.00mm
Typical Weight	6.4g (8-32GB)

Table 4-2: Mechanical Information - Standard SATA with large screw hole size

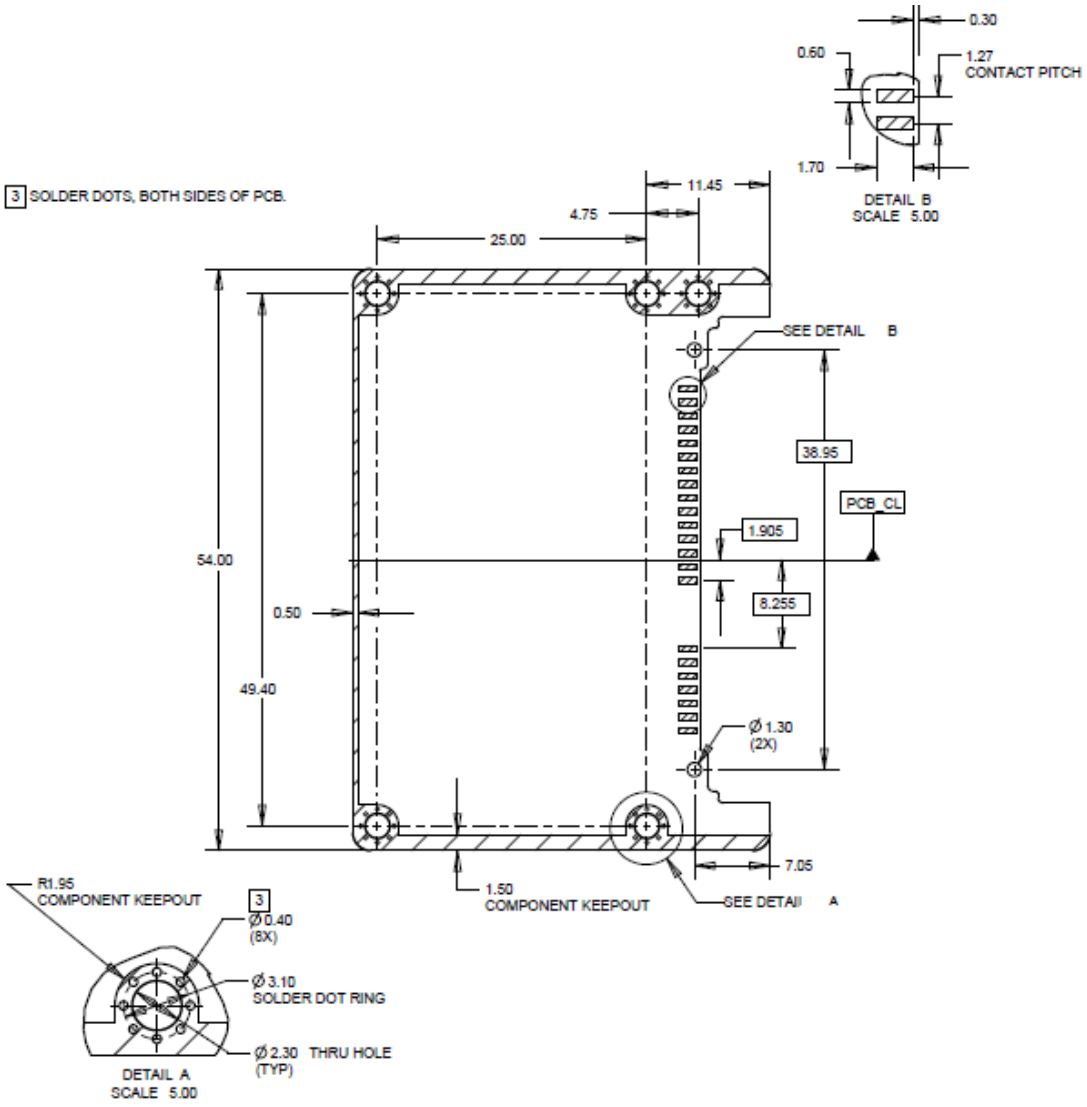

Figure 4-5: Standard SATA with large screw hole size Top View with more details

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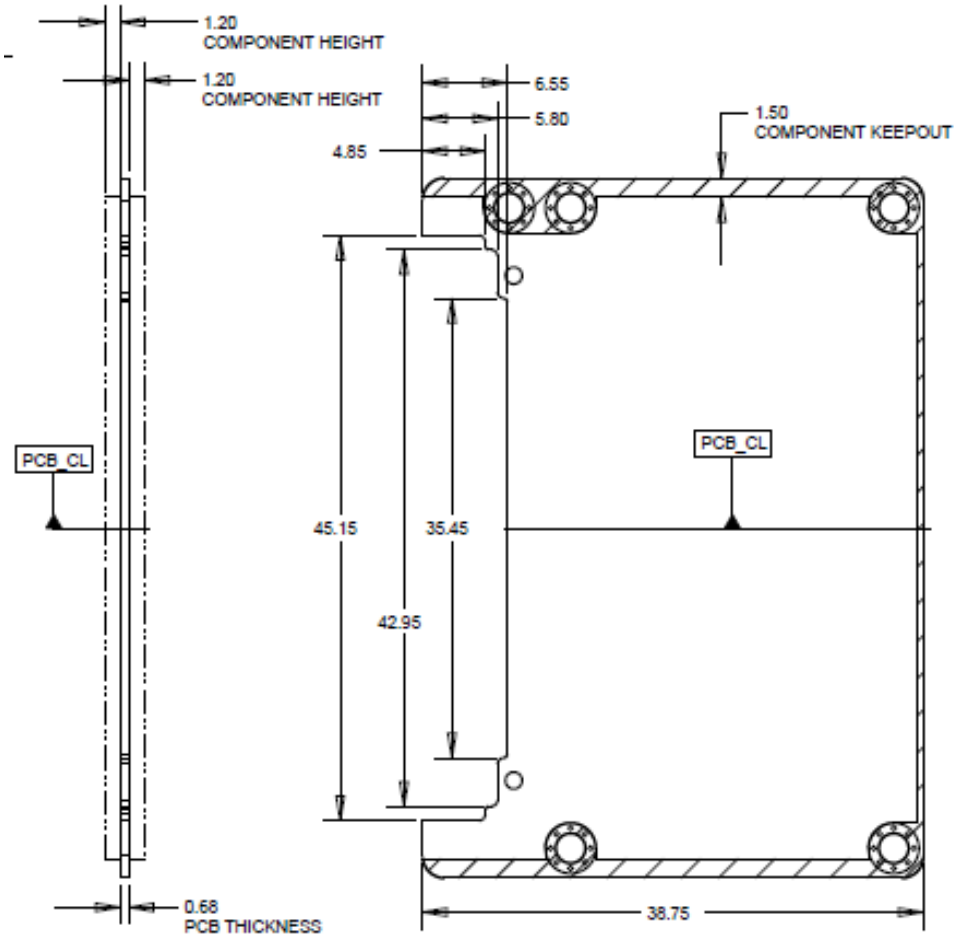

Figure 4-6: Standard SATA with large screw hole size Bottom View & Side view

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4.2 Half 1.8" – Micro-SATA Connector

Parameter	Specifications
Width	54mm
Length	39mm
Thickness (max)	3.08mm (8-64GB), 4.38mm (128GB) Connector 4.00mm
Typical Weight	5.9g (8-32GB), 6.9g (64GB), 8.1g (128GB)

Table 4-3: Mechanical Information - Micro-SATA form factor

4.2.1 Micro-SATA 8GB-64GB capacity

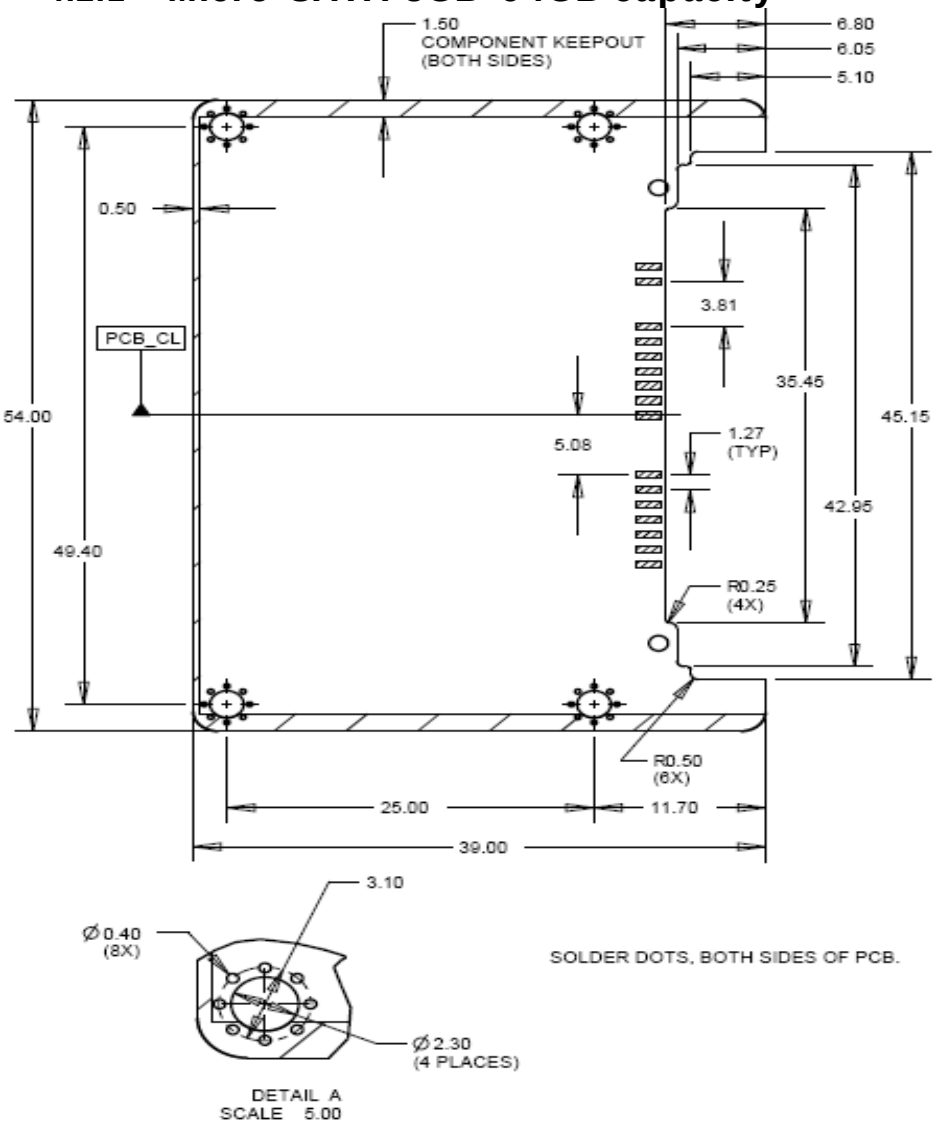

Figure 4-7: Micro-SATA 8GB-64GB Top/Bottom View

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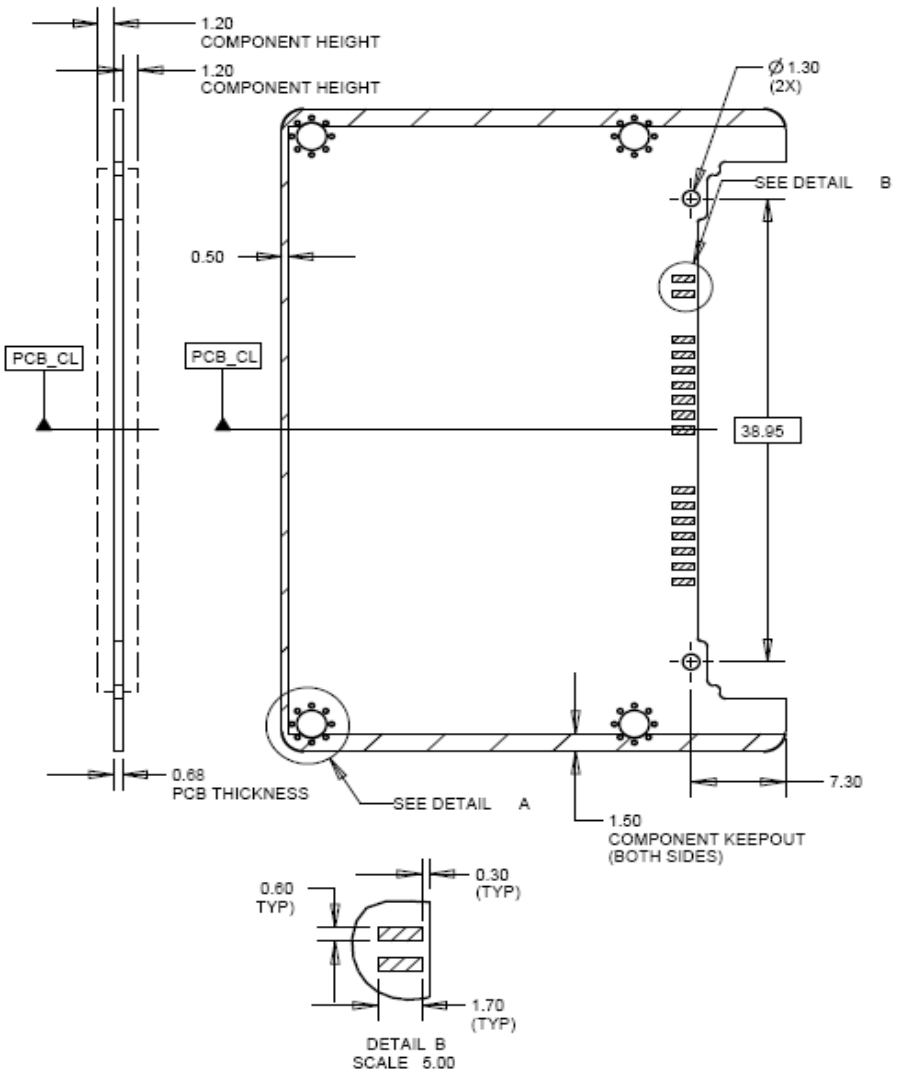

Figure 4-8: Micro-SATA 8GB-64GB Top and Side Views with more details

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4.2.2 Micro-SATA 128GB capacity

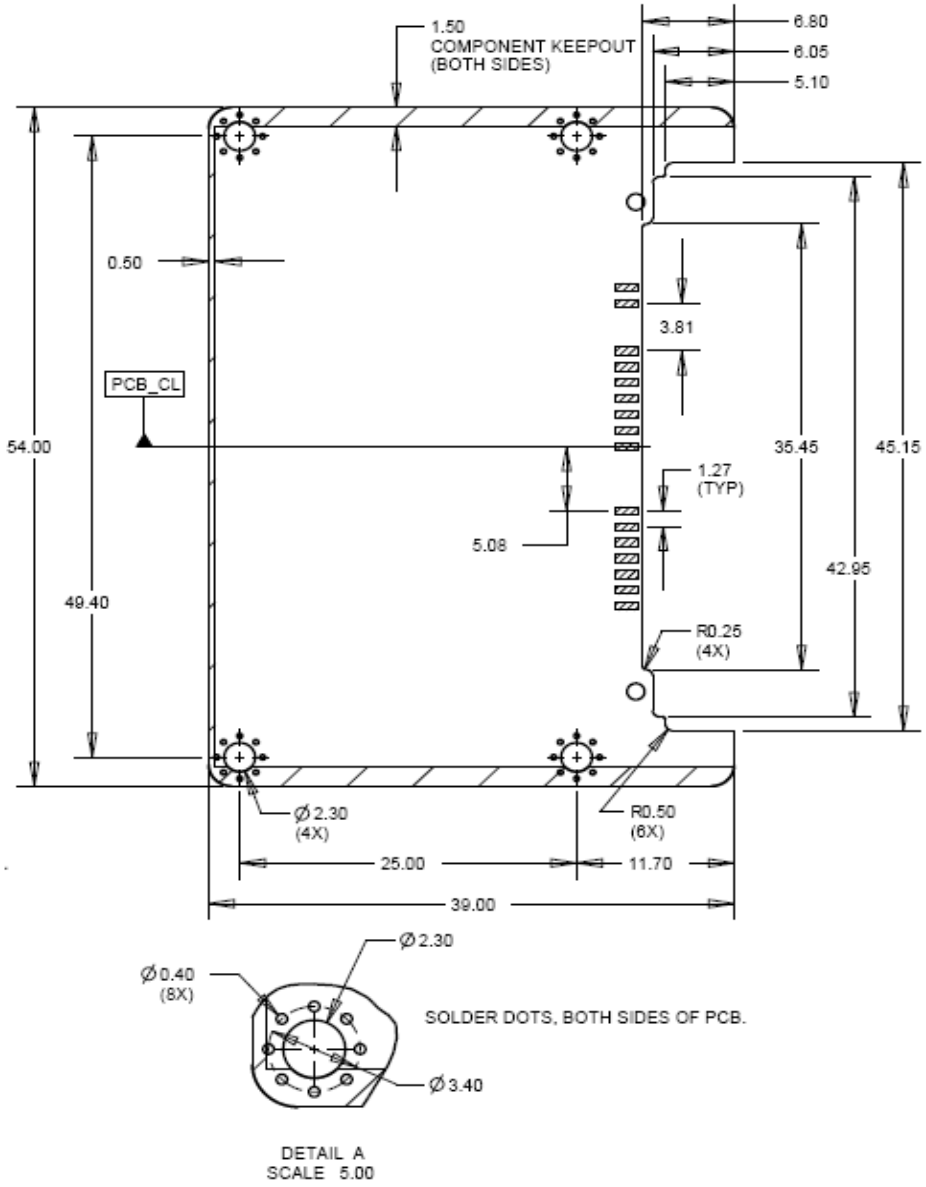

Figure 4-9: Micro-SATA 128GB Top/Bottom View

Downloaded from Arrow.com.

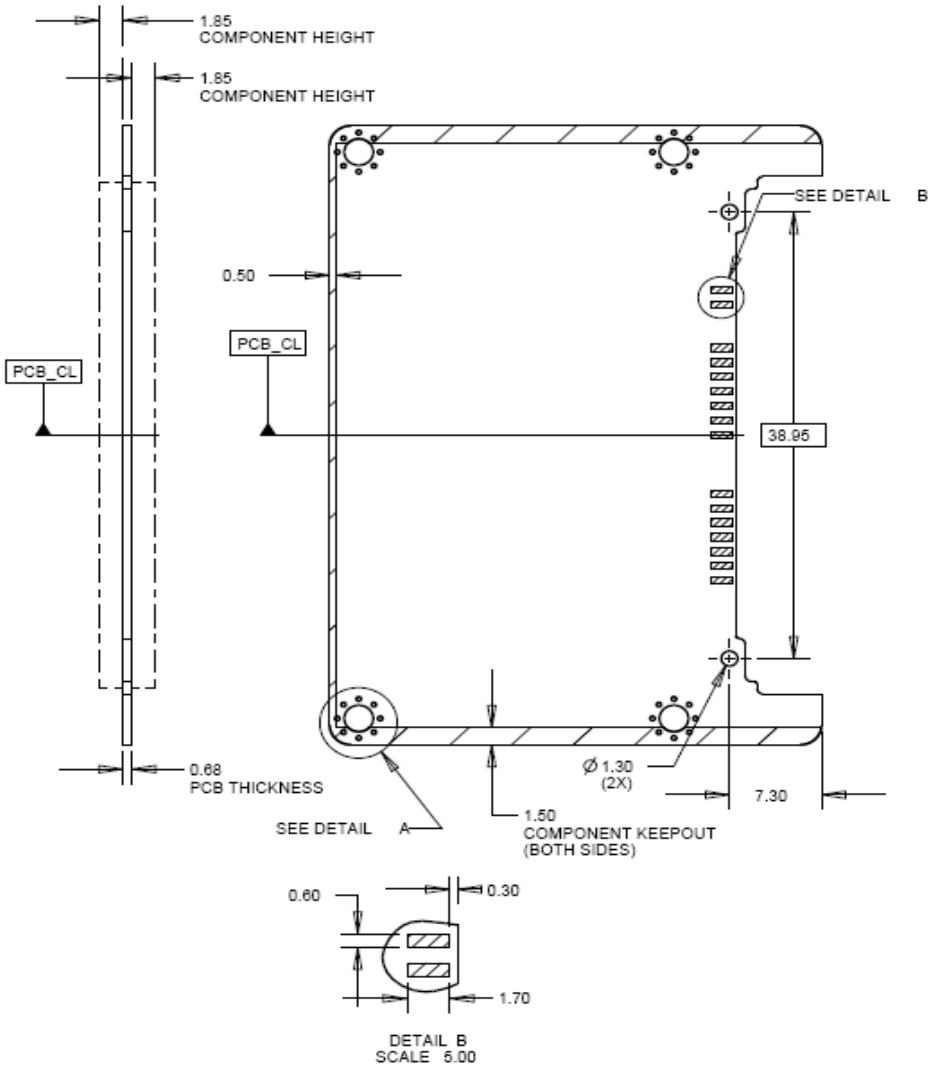

Figure 4-10: Micro-SATA 128GB Top View and Side View with more details

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4.3 mSATA Form Factor

Complies with MO-300 Standard

Parameter	Specifications
Width	30mm
Length	50.95mm
Thickness (max)	3.4mm (8-64GB), 3.7mm (128GB)
Typical Weight	5g (8-32GB), 6g (64GB), 7.2g (128GB)

Table 4-4: Mechanical Information - mSATA form factor

4.3.1 mSATA 8GB-64GB capacity

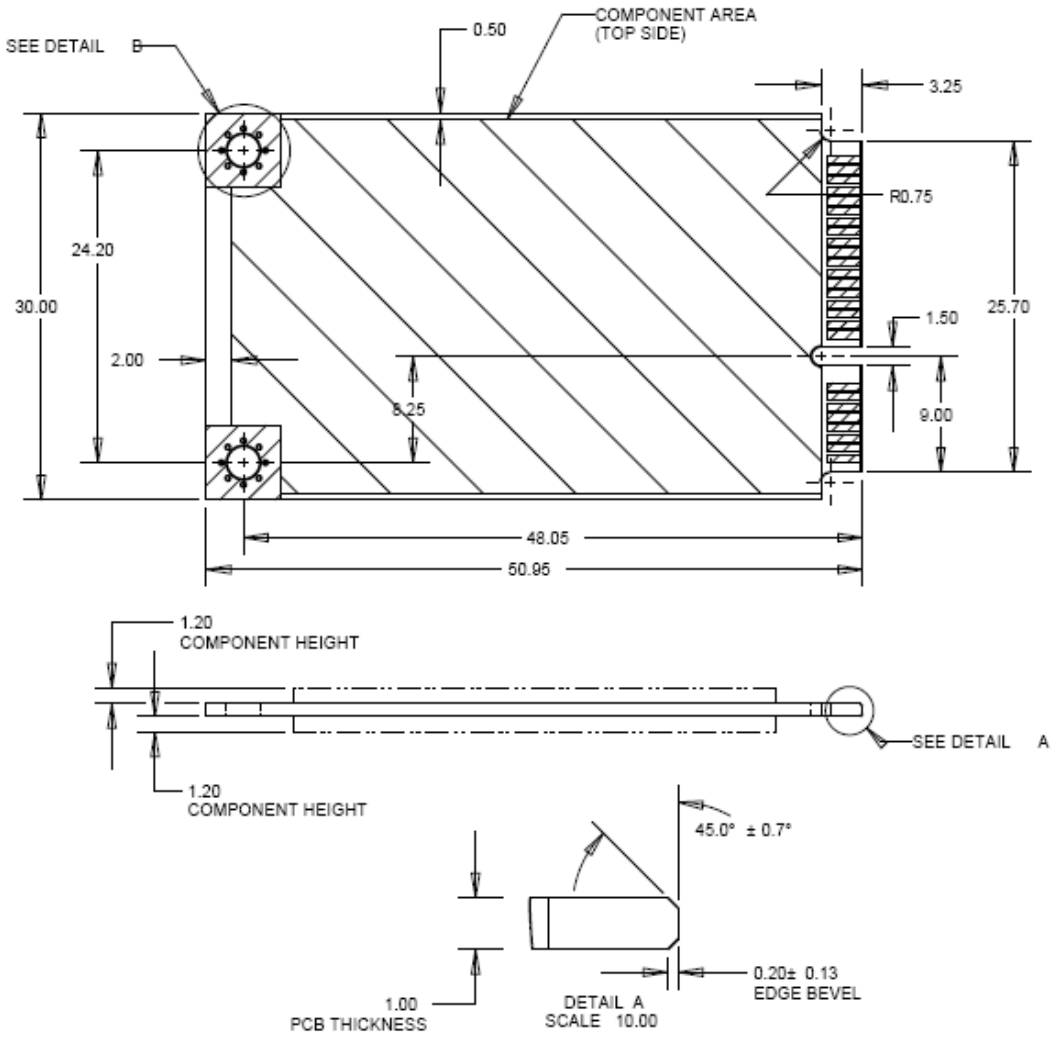

Figure 4-11: mSATA 8GB-64GB Top and Side View

Downloaded from Arrow.com.

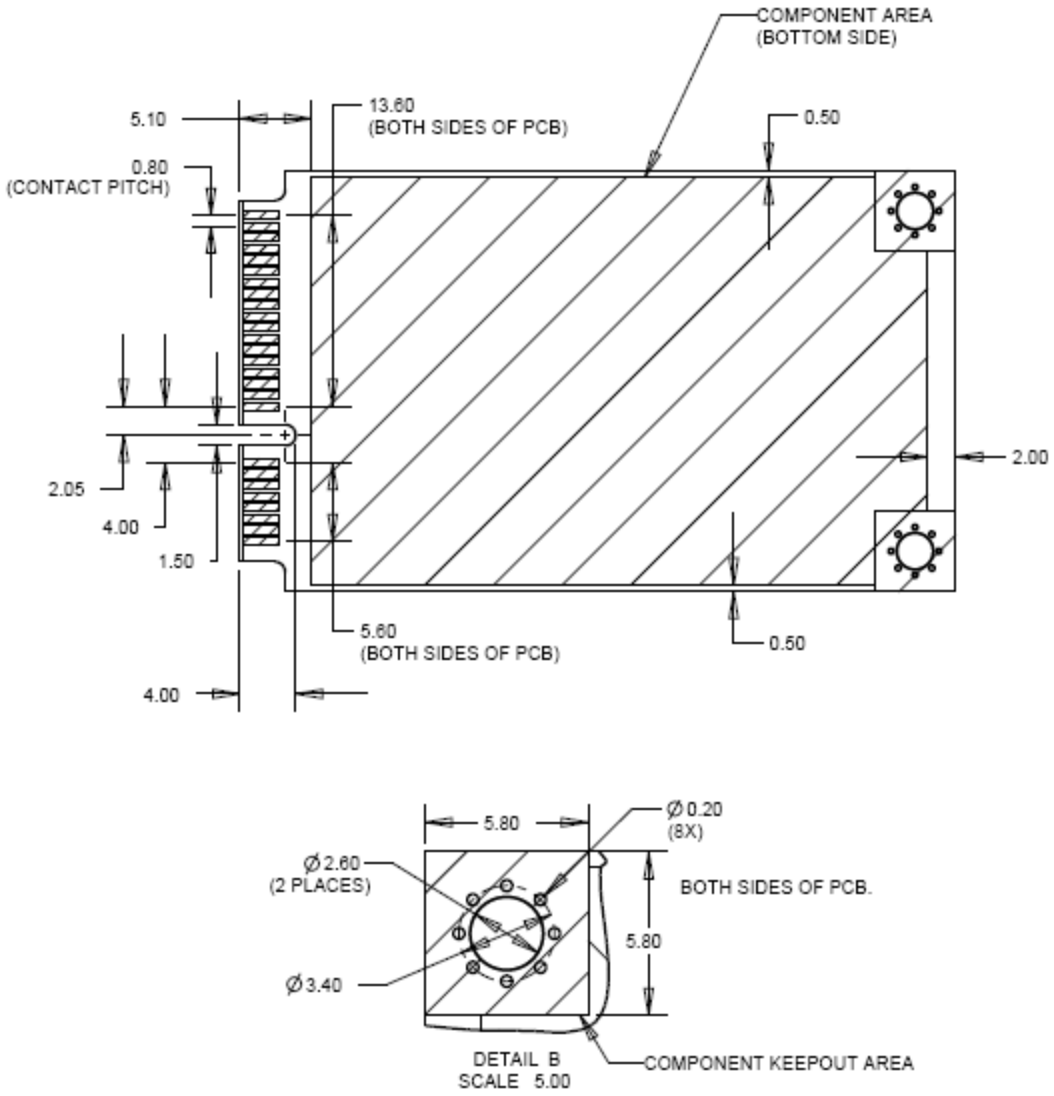

Figure 4-12: mSATA 8GB-64GB Bottom View

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4.3.2 mSATA 128GB capacity

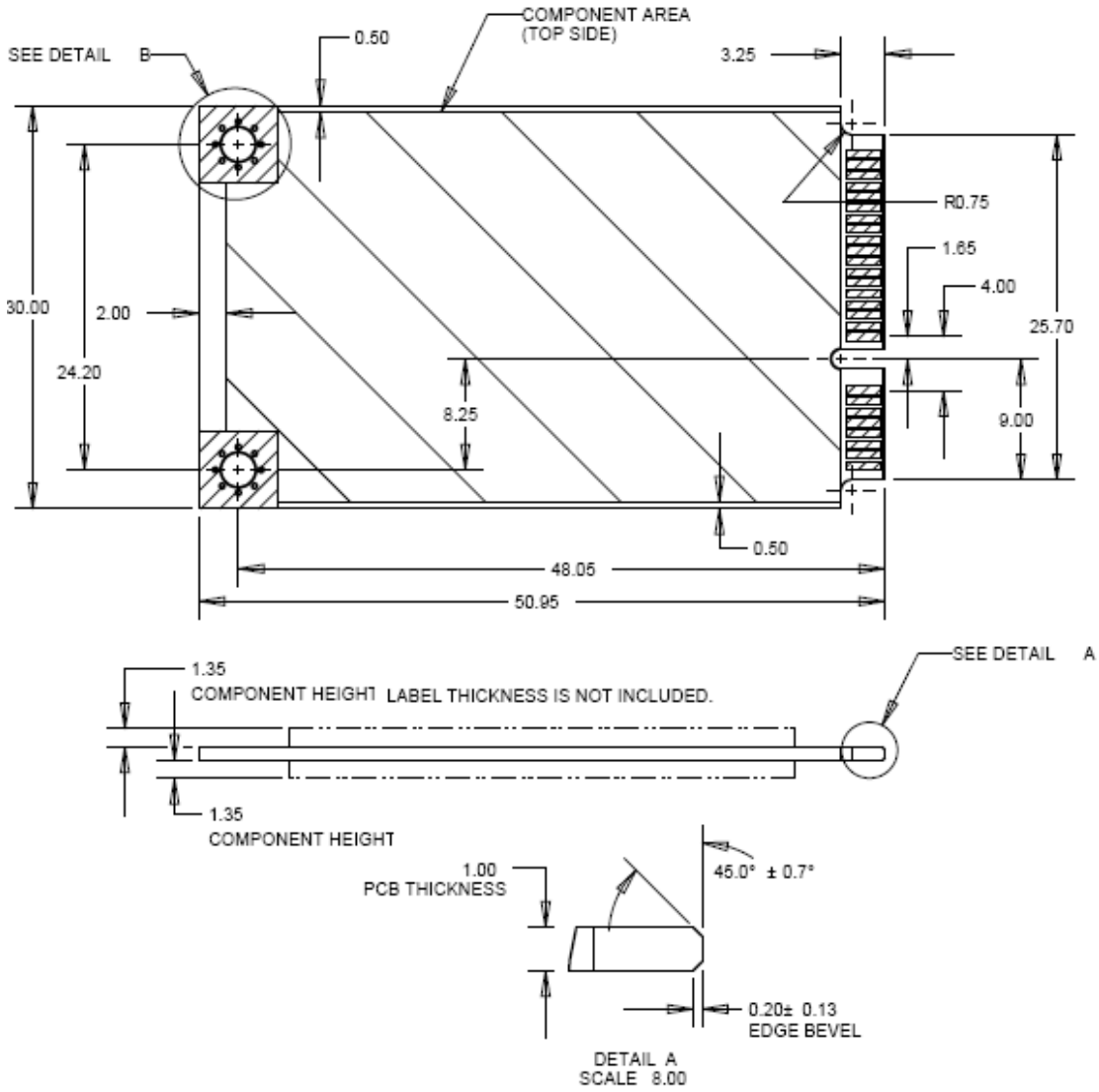

Figure 4-13: mSATA 128GB Top and Side views

Downloaded from Arrow.com.

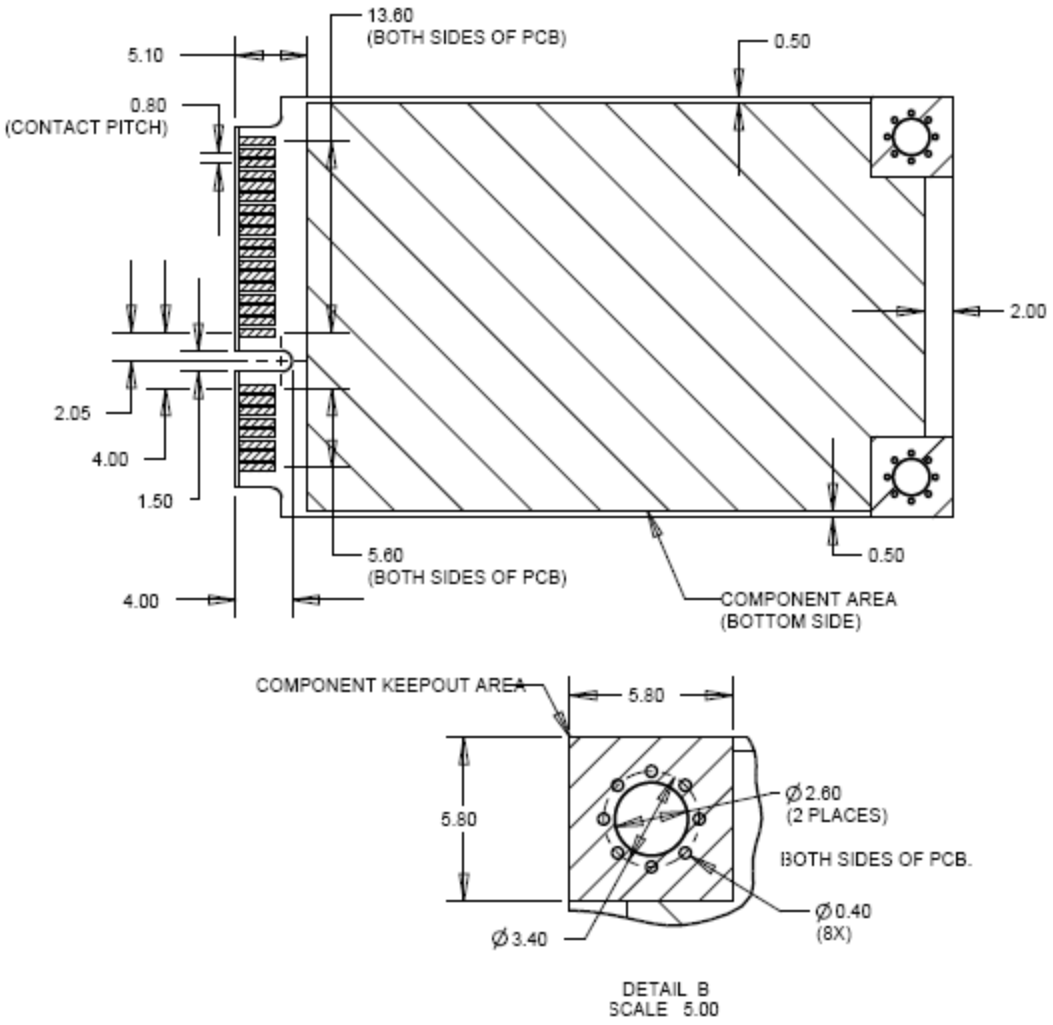

Figure 4-14: mSATA 128GB Bottom view

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4.4 mSATA Mini Form Factor

Complies with MO-300 Standard

Parameter	Specifications
Width	30mm
Length	26.80mm
Thickness (max)	3.4mm (8-32GB), 3.7mm (64GB)
Typical Weight	3.4g (8-32GB), 4.0g (64GB)

Table 4-5: Mechanical Information - mSATA Mini form factor

4.4.1 mSATA Mini 8GB-32GB capacity

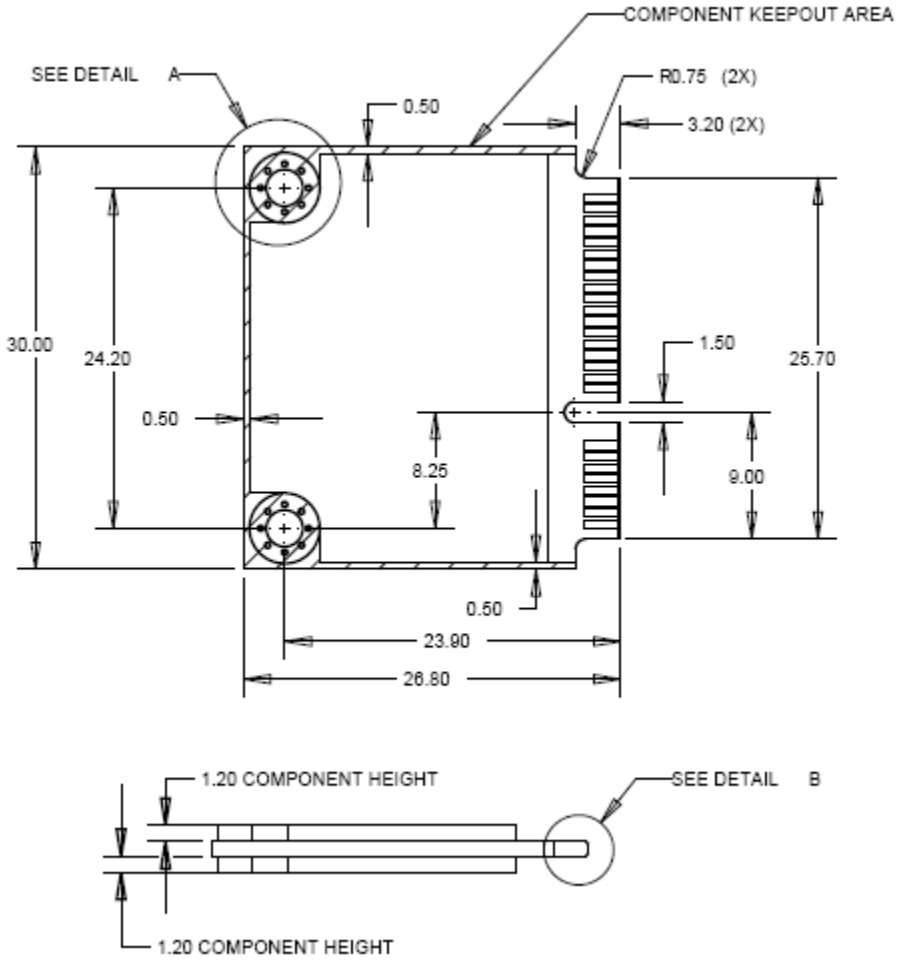

Figure 4-15: mSATA Mini 8GB-32GB Top and Side Views

Downloaded from Arrow.com.

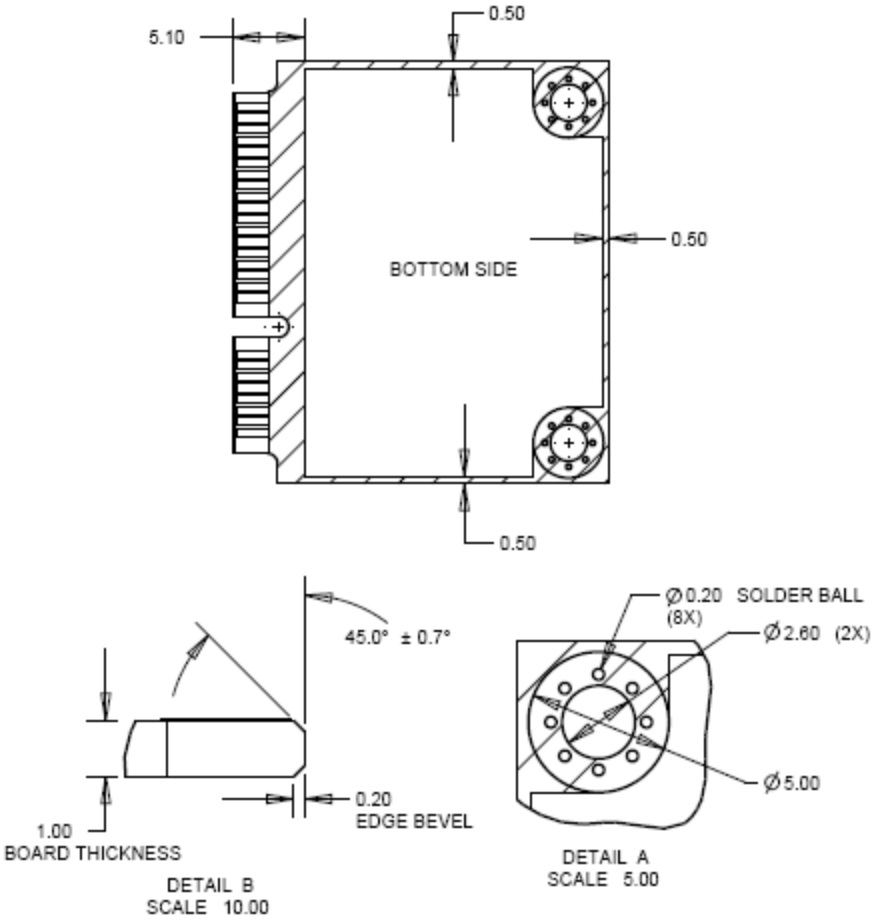

Figure 4-16: mSATA Mini 8GB-32GB Bottom View

Downloaded from Arrow.com.

4.4.2 mSATA Mini 64GB capacity

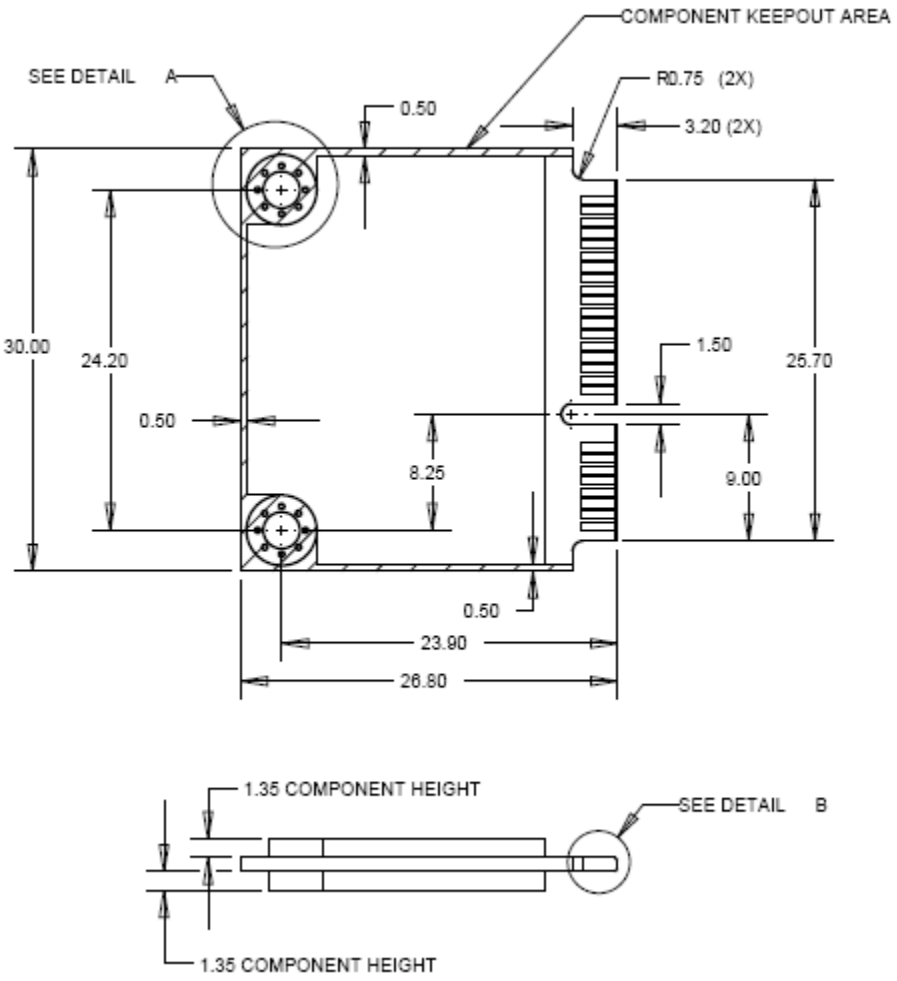

Figure 4-17: mSATA Mini 64GB Top and Side Views

Downloaded from Arrow.com.

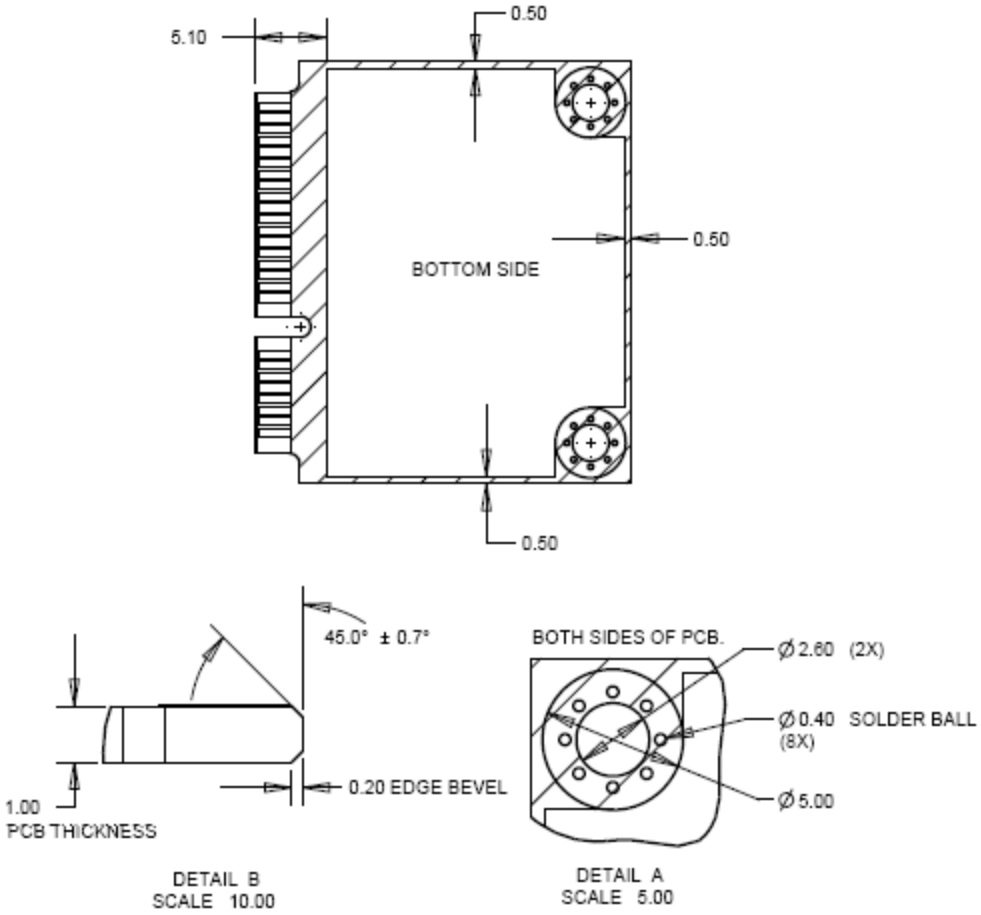

Figure 4-18: mSATA Mini 64GB Bottom View

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4.5 7mm Cased Form Factor

Complies to SFF-xxxx

Parameter	Specifications
Width	100.49mm
Length	69.85mm
Thickness (max)	7mm
Typical Weight	TBD

Table 4-6: Mechanical Information – 7mm Cased form factor

4.5.1 2.5” 7mm Cased Form Factor 4GB-64GB

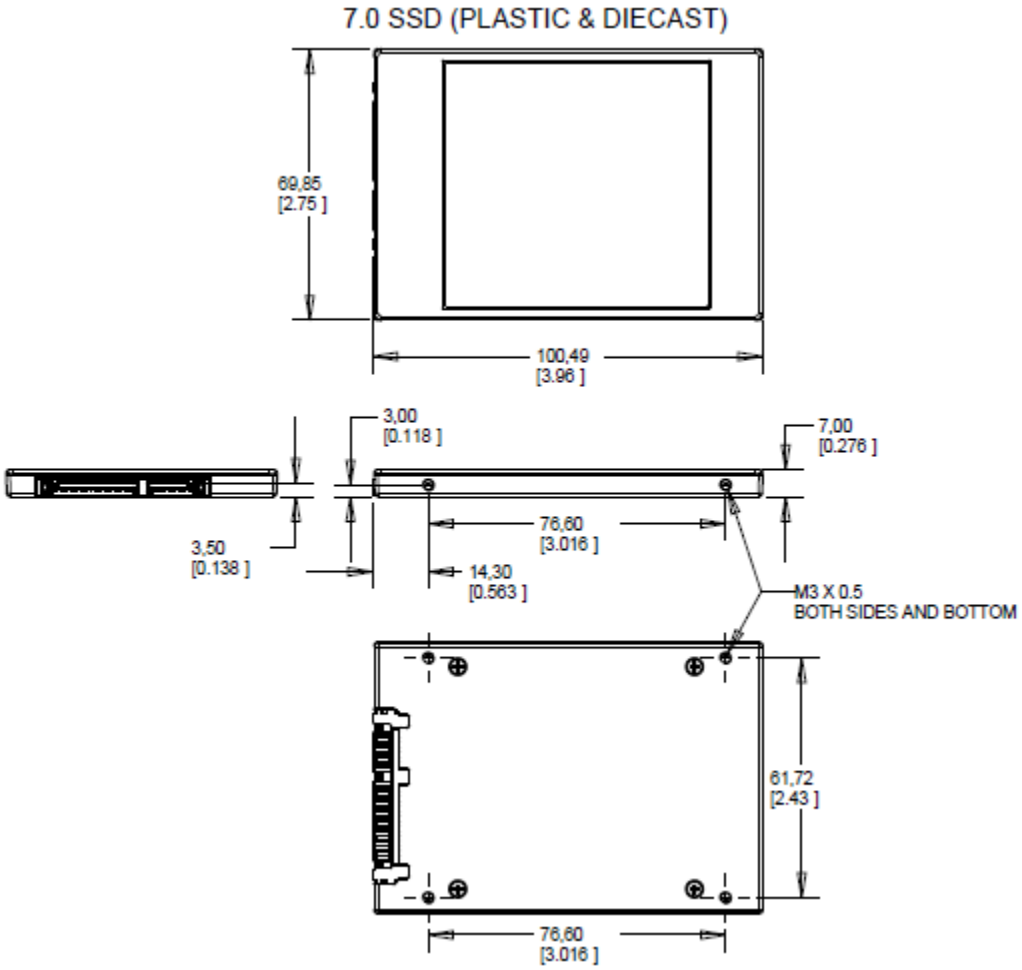

Figure 4-19: 2.5” 7mm cased Form Factor

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5. Environmental Specifications

5.1 Temperature

Parameter	Specifications
Operational	0°C to 70°C
Storage	-55°C to 85°C
Maximum temperature gradient	1°C per minute

Table 5-1: SanDisk SSD P4 Temperature Specification

5.2 Humidity

Parameter	Specifications
Operational	
Humidity (Non condensation)	5% to 95%
Maximum wet bulb	35°C
Non-operational	
Humidity (Non condensation)	5% to 95%
Maximum wet bulb	40°C
Maximum relative humidity gradient	20% per hour

Table 5-2: SanDisk SSD P4 Humidity Specification

5.3 Vibration

Parameter	Specifications
Operational / Non-operational	5gRMS, 10-2000 Hz, 3 axes

Table 5-3: SanDisk SSD P4 Vibration Specification

5.4 Shock

Parameter	Acceleration Force	Half Sine pulse duration
Operational /	1000G	1ms
Non operational	1500G	0.5ms

Table 5-4: SanDisk SSD P4 Shock Specification

5.5 Altitude

Parameter	Specifications
Non-Operational	-1500ft (-457m) to 40,000ft (12,192m)
Operational	-1500ft (-457m) to 10,000ft (3048m)

Table 5-5: SanDisk SSD P4 Altitude Specification

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5.6 Electrostatic Discharge (ESD)

The SanDisk SSD P4's are ESD tested per IEC 61000-4-2 Standard.

Parameter	Test Voltage
Contact	2kV, 4kV
Air	4kV, 8kV

Table 5-6: SanDisk SSD P4 ESD Specification

5.7 Acoustics

The SSD P4 does not generate any acoustics noise (0dB).

5.8 EMI/RFI Compliance

The SanDisk SSD P4 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 P4 EMI/RFI Compliance

5.9 RoHS

European union's restriction on use of hazardous substances in electrical and electronic equipment (EU RoHS) Directive 2002/95/EC.
China's management methods for controlling pollution by electronic information products (China RoHS).

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5.10 Regulations

The SanDisk SSD P4 is certified with the following certifications:

Standard
CE
UL (with file number)
CSA (or ULc)
CE
WEEE
TUV/SEMKO/UL/etc.
MIC (Korea) (with certification number)
BSMI (Taiwan) (with applicant code number)
VCCI (Japan)
C-Tick (Australia)
FCC
China RoHS
HF (Halogen Free)
EuP

Table 5-8: SanDisk SSD P4 Regulation Standards

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6. Reliability Characteristics

6.1 Error Rate

Non-recoverable error rate is 1 error per 10^{14} 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)	Estimated FITs
4GB	Telcordia SR-332, GB, 25°C	5,100,000	196
8GB	Telcordia SR-332, GB, 25°C	4,958,071	202
16GB	Telcordia SR-332, GB, 25°C	4,806,968	208
32GB	Telcordia SR-332, GB, 25°C	4,530,805	215
64GB	Telcordia SR-332, GB, 25°C	4,063,862	221
128GB	Telcordia SR-332, GB, 25°C	2,912,038	343

Table 6-1: SanDisk SSD P4 MTTF

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7. Interface

7.1 Supported Standards

The SSD P4 complies with the following standards:

SATA II, ver. 2.6
ATA-8 command set

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/RSS	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

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7.3 Pin Assignments – Micro-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	3.3V power
P2	V33	3.3V power – pre charge
P3	GND	GND
P4	GND	GND
P5	V5	Not Connected
P6	V5	Not Connected
P7	DAS	Device Activity Signal
P8	GND	GND
P9	Optional	Not Connected

Table 7-2: Micro-SATA Connector Pin Assignment

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7.4 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 the device	52	+3.3V	3.3V Source

Table 7-3: mSATA Connector Pin Assignment

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8. Supported ATA Commands

The following table defines some of the common ATA commands supported by the SSD P4. Specifics of each ATA command's operation can be found in the AT Attachment 8 – ATA/ATAPI Command Set (ATA-8 ACS) 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 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

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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 SATA features			10h
		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 SATA features			90h
		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:		**LBA Low**	D4h
		Execute off-line immediate routine	00h	

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		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
	Disable Auto 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 FUA Ext			M	3Dh
Write DMA w/o Retry			Obs	CBh
Write Log Ext			O	3Fh
Write Multiple			M	C5h
Write Multiple FUA Ext			M	CEh
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

Table 8-1: Supported ATA Commands

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8.1 Identify Data

The following table defines the specifics of the Identify Data returned by the SSD P4.

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	SSD 8.XX	8	Firmware revision in ASCII (left-justified)
27-46	SanDisk SSD P4 XXGB	40	Model number in ASCII (left-justified)
47	8001h	2	Maximum No. of sectors in Read/Write Multiple command
48	0000h	2	Reserved
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 (depends on capacity)
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 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)
66	0078h	2	Recommended multiword DMA transfer cycle time per word in ns

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Word Address	Default Value	Total Bytes	Data Field Type Information
67	0078h	2	Minimum PIO transfer without flow control
68	0078h	2	Minimum PIO transfer with IORDY flow control
69	1200h	2	ATA8-ACS2 Additional Supported
70-74	0000h	10	Reserved
75	0000h	2	Queue Depth
76	0206h	2	SATA capabilities
77	000Xh	2	SATA Additional capabilities (0002=1.5Gbps, 0004=3.0Gbps)
78	0048h	2	SATA Features Supported
79	0040h	2	SATA Features Enabled
80	01F0h	2	Major Version number
81	0107h	2	Minor Version number
82	746Bh	2	Command set supported
83	7D01h	2	Command sets supported
84	4163h	2	Command set/feature supported extension
85	7469h	2	Command set/feature enabled
86	BC01h	2	Command set/feature enabled
87	4163h	2	Command set/feature default
88	007Fh	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 (all capacities complete < 2 minutes)
91	0000h	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
104	0000h	2	Streaming Transfer Time-PIO
105	0001h	2	Max # 512-byte Blocks in LBA Range Entries
106	4000h	2	Physical Sector Size/Logical

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Word Address	Default Value	Total Bytes	Data Field Type Information
107	0000h	2	Inter-Seek Delay for ISO7779
108-111	5001B440XXXX XXXXh	8	WWN
112-115	0000h	8	Reserved
116	0000h	2	Reserved for TLC
117-118	0000h	4	Logical Sector Size
119	4004h	2	Command/Feature Sets Supported #4
120	4004h	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	0004h	2	Device Nominal Form Factor
169	0001h	2	ATA8-ACS2 Data Set Management Support
170-175	0000h	12	Reserved
176-205	0000h	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
220	0000h	2	Wr/Rd/Vfy Feature Set-Current Mode
221	0000h	2	Reserved
222	1011h	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 DL Microcode Mode 3
235	0000h	2	Max Sector Count for DL Microcode Mode 3

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Word Address	Default Value	Total Bytes	Data Field Type Information
236-254	0000h	38	Reserved for CE-ATA
255	XXXXh	2	Integrity Word-Checksum

Table 8-2: Identify Data Values

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8.2 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
0	1	General Purpose Log Directory
3	'n'	Ext Comprehensive SMART Error Log
6	1	SMART Self-Test Log
80h-9Fh	16	Host Vendor-specific Logs

Table 8-3: Supported SMART Log Pages

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9. Ordering information

SDSA4XH-CCCG-YYYY	
SD	SanDisk
SA	SATA
4	Generation: 3
X	Form factor: A – Half 1.8" form factor, Standard SATA connector B – Half 1.8" form factor, Standard SATA connector with large screw hole D – mSATA form factor E – Half 1.8" form factor, micro SATA connector F – mSATA Mini form factor G – 2.5" / 7mm cased product
H	Flash Memory used: 32nm 32Gb MLC ABL
CCC	Capacity: 004 008 016 032 064 128
G	Units: GB
YYYY	Customer code reference

Table 9-1: Ordering Information

Refer to the examples below as reference for ordering SKUs.

SKU #	**Details**
SDSA4**A**H-032G-YYYY	32GB SSD P4 in Half 1.8" form factor, Standard SATA connector
SDSA4**D**H-064G-YYYY	64GB SSD P4 in mSATA form factor
SDSA4**E**H-128G-YYYY	128GB SSD P4 in Half 1.8" form factor, Micro-SATA connector
SDSA4**F**H-016G-YYYY	16GB SSD P4 in mSATA Mini form factor

Table 9-2: Examples of decoded SKU

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10. Contact information

USA
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