RoHS Compliant

Serial ATA Flash Drive

Specifications for SAFD 18P

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Version 1.3

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Features:

- **Standard Serial ATA 2.6**
  - Serial ATA 2.6
  - SATA II, 3.0 Gbps
  - ATA-compatible command set
- **Capacities**
  - 8, 16, 32, 64, 128 GB
- **Performance***
  - Burst read/write: 300 MB/sec
  - Sustained read: up to 260 MB/sec
  - Sustained write: up to 215 MB/sec
- **Intelligent endurance design**
  - Built-in hardware ECC, enabling up to 16/24 bit correction per 1024 bytes
  - Static wear-leveling scheme together with dynamical block allocation to significantly increase the lifetime of a flash device and optimize the disk performance
  - Flash bad-block management
  - S.M.A.R.T.
  - Power Failure Management
  - ATA Secure Erase
  - TRIM
- **NAND Flash Type:** SLC
- **Temperature ranges**
  - Operation:
    Standard: 0℃ to 70℃ (32 ~ 158℉)
    Extended: -40℃ to 85℃ (-40° ~ 185℉)
  - Storage: -40℃ to 100℃ (-40° ~ 212℉)
- **Supply voltage**
  - 3.3V & 5V
- **Power consumption (typical)***
  - Active mode: 978 mA
  - Idle mode: 303 mA
- **Form factor**
  - 1.8 inch (78.5 x 54 x 5, unit: mm)
- **Connector**
  - 7-pin SATA male connector
  - 9-pin SATA power connector
- **Shock & Vibration****
  - Shock: 1500 G
  - Vibration: 15 G
- **MTBF >** 2,000,000 hours
- **RoHS compliant**

*Varies from capacities. The values addressed for performance and power consumption are typical and may vary depending on settings and platforms.

**Non-operating

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1. Product Description

1.1 Introduction

Apacer's Serial ATA Flash Drive (SAFD) is a solid-state disk (SSD) drive that contains a controller, embedded firmware, and flash media along with a male connector. Using NAND flash memory devices, the drive transfers data between the host and the storage devices at a dramatically higher speed than traditional hard drives.

SAFD 18P drive is designed with a single-chip controller, offering capacities of up to 128 gigabytes and providing full support for the SATA II high-speed interface standard. It can operate at sustained access rates of up to higher than 260 megabytes per second, which is much more ideal for storage than traditional SATA-based hard disk drive currently available on the market.

In addition, SAFD 18P adopts the Apacer-specific static wear-leveling scheme to allow uniform use of all storage blocks, ensuring that the lifetime of a flash media can be significantly increased and the disk performance is optimized as well. SAFD 18P provides the S.M.A.R.T. feature that follows the SATA Rev. 2.6, ATA/ATAPI-7 specifications and uses the standard SMART command B0h to read data from the drive. This feature protects the user from unscheduled downtime by monitoring and storing critical drive performance.

1.2 Functional Block Diagram

SAFD 18P drive includes a single-chip SATA II Controller and the flash media, as well as the SATA standard interface. The controller integrates the flash management unit with the controller itself to support multi-channel, multi-bank flash arrays. Figure 1-1 shows the functional block diagram.

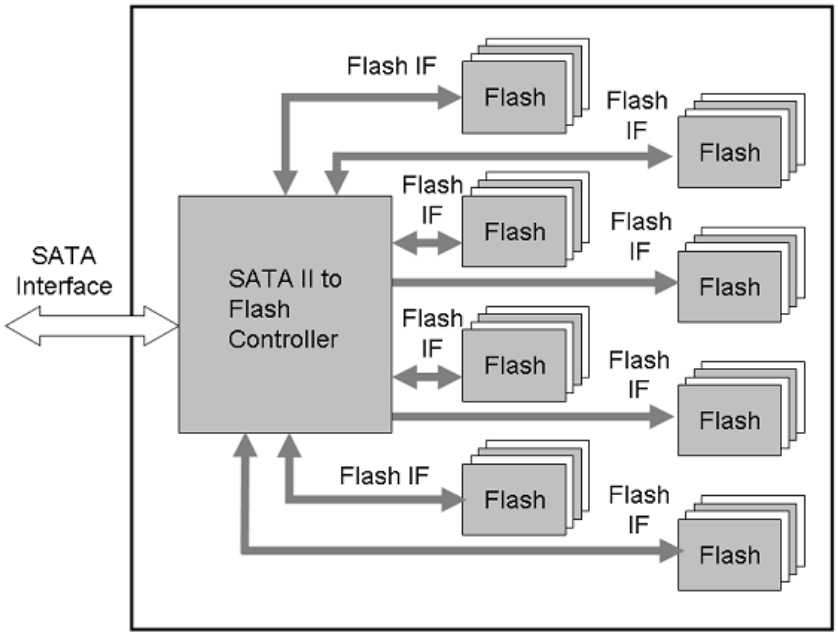


Figure 1-1 Apacer SAFD 18P block diagram

1.3 ATA Mode Support

SAFD 18P provides ATA mode support as follows:

- Up to PIO mode-4
- Up to Multiword DMA mode-2
- Up to UDMA mode-4

1.4 Capacity Specification

Capacity specification of SAFD 18P product family is available as shown in Table 1-1. It lists the specific capacity, the default numbers of logical cylinders and heads, and the number of logical sectors per track for each product line.

Table 1-1 Capacity specification

Capacity	Total Bytes*	Cylinders	Heads	Sectors	Max LBA**
8 GB	7,012,196,352	13,587	16	63	13,695,696
16 GB	16,013,942,784	16383	16	63	31,277,232
32 GB	32,017,047,552	16,383	16	63	62,533,296
64 GB	64,023,257,088	16383	16	63	125,045,44
128 GB	128,035,676,10	16383	16	63	250,069,60

*Display of total bytes varies from file systems.
**Cylinders, heads or sectors are not applicable for these capacities. Only LBA addressing applies.
***Notes: 1 GB = 1,000,000,000 bytes; 1 sector = 512 bytes.
LBA count addressed in the table above indicates total user storage capacity and will remain the same throughout the lifespan of the device. However, the total usable capacity of the SSD is most likely to be less than the total physical capacity because a small portion of the capacity is reserved for device maintenance usages.

1.5 Performance

Performance of SAFD 18P is shown in Table 1-2.

Table 1-2 Performance specifications

Capacity / Performance	8 GB	16 GB	32 GB	64 GB	128 GB
Sustained Read (MB/s)	255	260	260	260	245
Sustained Write (MB/s)	100	205	190	215	165

Note:
Performances vary from flash configurations and host system configurations.
Read/write performance is measured using CrystalDiskMark under Windows XP operating sytem.

1.6 Pin Assignments

Table 1-3 describes SAFD 18P signal segment, and Table1-4, its power segment.

Figure 1-2 Micro-SATA Connectors

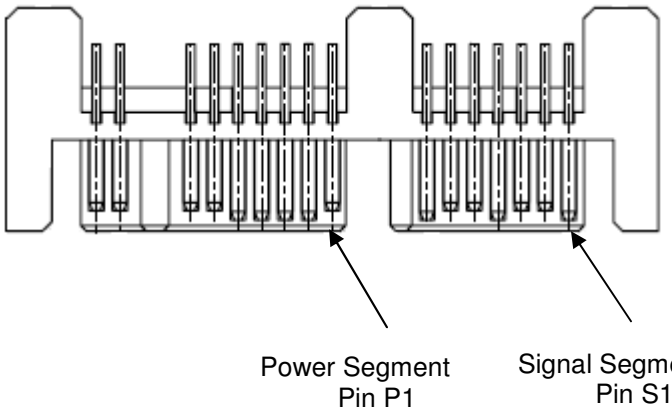


Table 1-3 Signal segment

Name	Type	Description
S1	GND	
S2	RxP	+ Differential Receive Signal
S3	RxN	- Differential Receive Signal
S4	GND	
S5	TxN	- Differential Transmit Signal
S6	TxP	+ Differential Transmit Signal
S7	GND	

Table 1-4 Power segment

Pin	Type	Signal/Description
P1	V33	3.3 V Power
P2	V33	3.3 V Power
P3	GND	
P4	GND	
P5	V5	5 V Power
P6	V5	5 V Power
P7	GND	Ground/Reserved
P8	Optional	NC
P9	Optional	NC

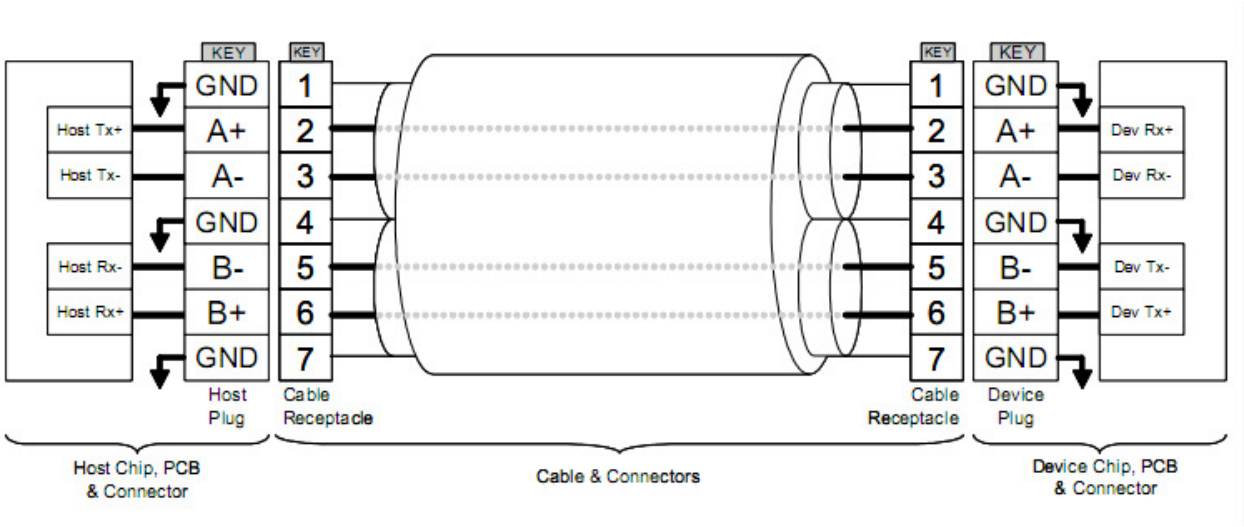


Figure 1-3 SATA Cable/Connector Connection Diagram

The connector on the left represents the Host with TX/RX differential pairs connected to a cable. The connector on the right shows the Device with TX/RX differential pairs also connected to the cable. Notice also the ground path connecting the shielding of the cable to the Cable Receptacle.

2. Software Interface

2.1 Command Set

Table 2-1 summarizes the ATA commands supported by SAFD 18P.

Table 2-1 Command set (1 of 2)

Command	Code	FR[1]	SC[2]	SN[3]	CY[4]	DH[5]	LBA[6]
Check-Power-Mode	E5H	-	-	-	-	D[8]	-
Execute-Drive-Diagnostic	90H	-	-	-	-	D	-
Flush-Cache	E7H	-	-	-	-	D	-
Identify-Drive	ECH	-	-	-	-	D	-
Idle	E3H	-	Y	-	-	D	-
Idle-Immediate	E1H	-	-	-	-	D	-
Initialize-Drive-Parameters	91H	-	Y	-	-	Y	-
Read-DMA	C8H or C9H	-	Y	Y	Y	Y	Y
Read-Multiple	C4H	-	Y	Y	Y	Y	Y
Read-Sector(s)	20H or 21H	-	Y	Y	Y	Y	Y
Read-Verify-Sector(s)	40H or 41H	-	Y	Y	Y	Y	Y
Recalibrate	10H	-	-	-	-	D	-
Security-Disable-Password	F6H	-	-	-	-	D	-
Security-Erase-Prepare	F3H	-	-	-	-	D	-
Security-Erase-Unit	F4H	-	-	-	-	D	-
Security-Freeze-Lock	F5H	-	-	-	-	D	-
Security-Set-Password	F1H	-	-	-	-	D	-
Security-Unlock	F2H	-	-	-	-	D	-
Seek	7XH	-	-		Y	Y	
Set-Features	EFH	Y[7]	-	-	-	D	-

Table 2-1 Command set (2 of 2)

Command	Code	FR[1]	SC[2]	SN[3]	CY[4]	DH[5]	LBA[6]
Set-Multiple-Mode	C6H	-	Y	-	-	D	-
Sleep	E6H	-	-	-	-	D	-
SMART	B0H	Y	Y	Y	Y	D	
Standby	E2H	-	-	-	-	D	-
Standby-Immediate	E0H	-	-	-	-	D	-
Write-DMA	CAH	-	Y	Y	Y	Y	Y
Write-Multiple	C5H	-	Y	Y	Y	Y	Y
Write-Sector(s)	30H	-	Y	Y	Y	Y	Y

1. FR - Features register
2. SC - Sector Count register
3. SN - Sector Number register
4. CY - Cylinder registers
5. DH - Drive/Head register
6. LBA - Logical Block Address mode supported (see command descriptions for use)
7. Y - The register contains a valid parameter for this command.
8. For the Drive/Head register:
Y means both the SAFD and Head parameters are used
D means only the SAFD parameter is valid and not the Head parameter

2.2 S.M.A.R.T.

S.M.A.R.T. is an acronym for Self-Monitoring, Analysis and Reporting Technology, an open standard allowing disk drives to automatically monitor their own health and report potential problems. It protects the user from unscheduled downtime by monitoring and storing critical drive performance and calibration parameters. Ideally, this should allow taking proactive actions to prevent impending drive failure.

Apacer devices use the standard SMART command B0h to read data out from the drive to activate our S.M.A.R.T. feature that complies with the ATA/ATAPI-7 specifications. Based on the SFF-8035i Rev. 2.0 specifications, S.M.A.R.T. Attribute IDs shall include initial bad block count, bad block count, spare block count, maximum erase count, average erase count and power cycle. When the S.M.A.R.T. Utility running on the host, it analyzes and reports the disk status to the host before the device reaches in critical condition.

3. Flash Management

3.1 Error Correction/Detection

SAFD 18P implements hardware ECC scheme based on the BCH algorithm which can detect and correct up to 16 bits or 24 bits error in 1024 bytes.

3.2 Flash Block Management

Current production technology is unable to guarantee total reliability of NAND flash memory array. When a flash memory device leaves factory, it comes with a minimal number of initial bad blocks during production or out-of-factory as there is no currently known technology that produce flash chips free of bad blocks. In addition, bad blocks may develop during program/erase cycles. When host performs program/erase command on a block, bad block may appear in Status Register. Since bad blocks are inevitable, the solution is to keep them in control. Apacer flash devices are programmed with ECC, block mapping technique and S.M.A.R.T to reduce invalidity or error. Once bad blocks are detected, data in those blocks will be transferred to free blocks and error will be corrected by designated algorithms.

3.3 Wear Leveling

Flash memory devices differ from Hard Disk Drives (HDDs) in terms of how blocks are utilized. For HDDs, when a change is made to stored data, like erase or update, the controller mechanism on HDDs will perform overwrites on blocks. Unlike HDDs, flash blocks cannot be overwritten and each P/E cycle wears down the lifespan of blocks gradually. Repeatedly program/erase cycles performed on the same memory cells will eventually cause some blocks to age faster than others. This would bring flash storages to their end of service term sooner. Wear leveling is an important mechanism that level out the wearing of blocks so that the wearing-down of blocks can be almost evenly distributed. This will increase the lifespan of SSDs. Commonly used wear leveling types are Static and Dynamic.

3.4 Power Failure Management

Power Failure Management ensures data transmission when experiencing unstable power supply. When power disruption takes places, NAND Flash will have to cache multiple write-to-flash cycles to ensure that no data is lost. This urgent operation requires about several milliseconds to get it done. When the supplied voltage is below a certain percentage of the required, the flash controller will be signaled by a detector IC component with low power detection signal and then the firmware will communicate the controller to flush all the data into the cache of Flash storage area. This can prevent incomplete data transmission.

3.5 ATA Secure Erase

ATA Secure Erase is an ATA disk purging command currently embedded in most of the storage drives. Defined in ATA specifications, (ATA) Secure Erase is part of Security Feature Set that allows storage drives to erase all user data areas. The erase process usually runs on the firmware level as most of the ATA-based storage media currently in the market are built-in with this command. ATA Secure Erase can securely wipe out the user data in the drive and protects it from malicious attack.

3.6 TRIM

TRIM, though in capital letters usually, is a memory computation command rather than an abbreviation. It is mainly a SATA command that enables the operating system to inform the SSD (Solid State Drive) which blocks of previously stored data are no longer valid, due to erases by the host or operating system, such as file deletions or disk formatting. Once notified, SSD will begin the discard of the invalid LBAs and retain more space for itself, in fact, the discarded is no longer recoverable.

When an LBA is replaced by the operating system, as with overwrite of a file, the SSD is informed that the originally occupied LBA is determined as no longer in use or invalid. The SSD will not save those blocks in garbage collected sectors. Noticeably, a file deletion command by host or operating system never actually erases the actual content, rather, just the file is marked as deleted. This issue is even specifically noticeable for flash based memory devices, such as SSDs. In fact, an SSD will keep garbage collecting the invalid, previously occupied LBAs, if it is not informed that these LBAs can be erased. Thus, the SSD would experience a significant performance downfall.

4. Environmental Specifications

4.1 Environments

SAFD 18P environmental specifications follow the US Military Standard MIL-STD-810F, as shown in Table 4-1.

Table 4-1 SAFD 18P environmental specifications

Environment	Specification
Temperature	0℃ to 70℃ (Operating – Standard); -40℃ to 85℃ (Operating – ET*)
	-40℃ to 100℃ (Non-operating)
Vibration**	Sine wave, 10 ~ 2000Hz Acceleration 15 G, X, Y, Z axis
Shock**	Half sine wave 1500 G, ± X, ±Y, ±Z axis

*Extended Temperature
**Non-operating conditions

4.2 Mean Time Between Failures (MTBF)

Mean Time Between Failures (MTBF) is predicted based on reliability data for the individual components in SAFD drive. Serving as statistical reference, the prediction result for SAFD 18P is more than 2,000,000 hours.

Notes about the MTBF:

The MTBF is predicated and calculated based on “Telcordia Technologies Special Report, SR-332, Issue 2” method.

4.3 Certification and Compliance

SAFD 18P drive complies with the following standards:

- CE – EN55022/55024
- FCC 47CFR Part15 Class B
- RoHS
- MIL-STD-810F
- SATA II (SATA Rev. 2.6)
- Up to ATA/ATAPI-7 (including S.M.A.R.T.)

5. Electrical Characteristics

5.1 Operating Voltage

Table 5-1 lists the supply voltage for SAFD 18P.

Table 5-1 SAFD 18P operating voltage

Parameter	Conditions
Supply voltage	3.3V ±5% (3.135-3.465V) / 5V ±5% (4.75-5.25V)

5.2 Power Consumption

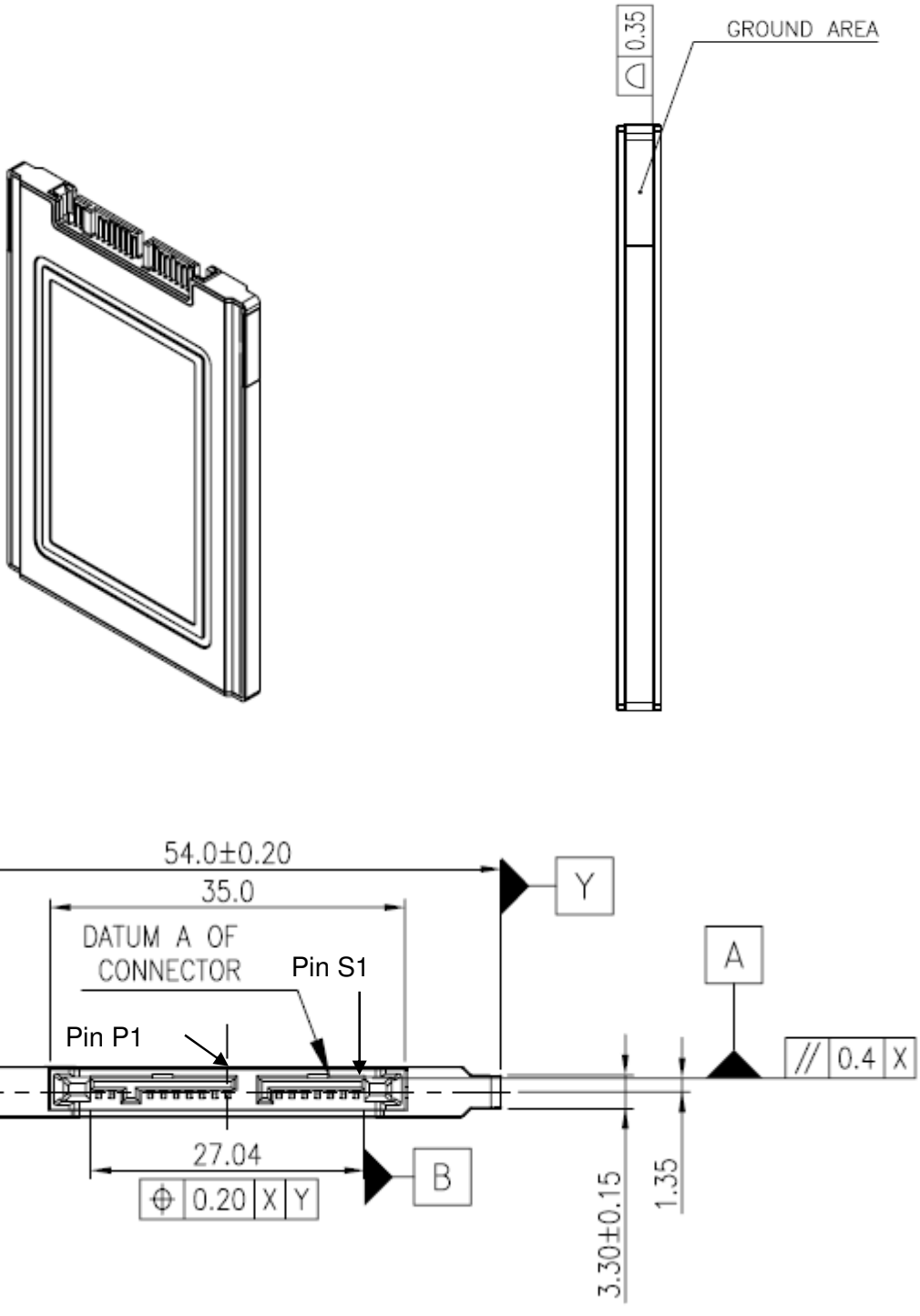
Table 5-2 lists SAFD 18P power consumption.

Table 5-2 SAFD 18P power consumption (Typical)

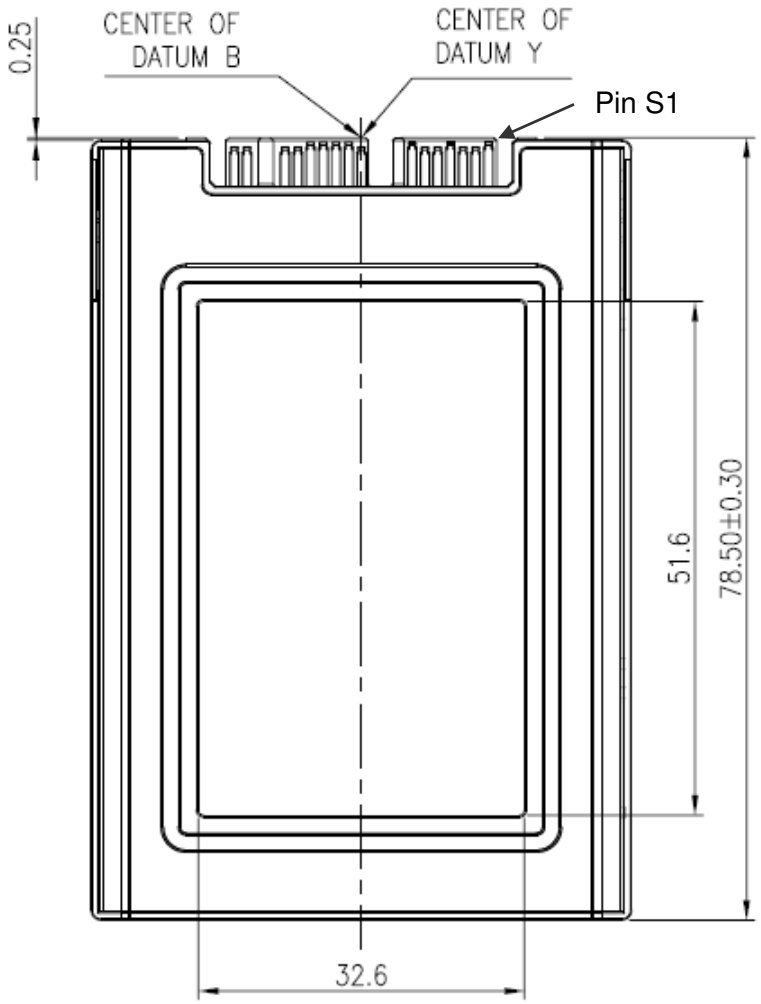
Mode \ Capacity	8 GB	16 GB	32 GB	64 GB	128 GB
Active Mode (mA)	610	920	978	800	600
Idle Mode (mA)	290	300	303	300	250

Note: power consumptions may vary depending on different flash configurations or platforms.

6. Physical Characteristics



Unit: mm
Tolerance: ± 0.2



Unit: mm
Tolerance: ± 0.2

7. Product Ordering Information

7.1 Product Code Designations

A P S 18P 6 A x x x x – D X X X

Voltage
Blank: 5V
L: 3.3V

Temperature Range
Blank: Standard
W: Extended Temperature

Flash Type
T: Toshiba
C: Micron

Version Control

Capacities:

008G:	08 GB
016G:	16 GB
032G:	32 GB
064G:	64 GB
128G:	128 GB

Apacer Brand

Solution version

1.8 inch Form Factor

Serial ATA Flash Drive

Apacer Product Code

7.2 Valid Combinations

SAFD18P (voltage: 5V)

Capacity	Standard	Extended Temperature
8 GB	APS18P6A008G-DT	APS18P6A008G-DTW
16 GB	APS18P6A016G-DT	APS18P6A016G-DTW
32 GB	APS18P6A032G-DT	APS18P6A032G-DTW
64 GB	APS18P6A064G-DC	APS18P6A064G-DCW
128 GB	APS18P6A0128G-DC	APS18P6A128G-DCW

SAFD18P (voltage: 3.3V)

Capacity	Standard	Extended Temperature
8 GB	APS18P6A008G-DTL	APS18P6A008G-DTWL
16 GB	APS18P6A016G-DTL	APS18P6A016G-DTWL
32 GB	APS18P6A032G-DTL	APS18P6A032G-DTWL
64 GB	APS18P6A064G-DCL	APS18P6A064G-DCWL
128 GB	APS18P6A128G-DCL	APS18P6A128G-DCWL

Note: Please consult with Apacer sales representatives for availabilities.

Revision History

Revision	Description	Date
0.1	Preliminary release	09/02/2011
0.2	Added 64GB & 128GB capacities Updated Product Ordering Information	10/17/2011
0.3	Updated Product Ordering Information	11/17/2011
1.0	Official release	11/30/2011
1.1	Revised S.M.A.R.T information	03/23/2012
1.2	Added Endurance subsection Revised Environmental section	05/24/2012
1.3	Updated Product Ordering Information due to firmware upgrade	11/09/2012

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