RoHS Compliant

Serial ATA Flash Drive

Specifications for SAFD 18P-M

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Version 1.5

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Features:

- **Standard Serial ATA 2.6**
  - Serial ATA 2.6
  - SATA II, 3.0 Gbps
  - ATA-compatible command set
  - ATA modes support
- **Capacities**
  - 16, 32, 64, 128, 256 GB
- **Performance***
  - Burst read/write: 300 MB/sec
  - Sustained read: up to 250 MB/sec
  - Sustained write: up to 165 MB/sec
  - Random read/write 4K: up to 4224/4285 IOPS
- **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
- **NAND Flash Type:** MLC
- **Endurance:** 9.39 TBW (16GB), 18.78 TBW (32GB), 37.57 TBW (64GB), 75.15 TBW (128GB) and 150.30 TBW (256GB)
- **MTBF >** 1,000,000 (approx)
- **Humidity**
  - 5% to 95% RH (Non-condensing)
- **Temperature ranges**
  - Operation:
    Standard: 0°C to 70°C (32 ~ 158°F)
    Extended: -40 ~ +85°C (-40° ~ 185°F)**
  - Storage: -40°C to 100°C (-40° ~ 212°F)
- **Supply voltage**
  - 3.3V & 5V
- **Cache on board:** 64 MB
- **Power consumption (Typical)***
  - Active mode: 819 mA
  - Idle mode: 194 mA
- **Form factor**
  - 1.8 inch SATA Flash Drive (78.5 x 54 x 5, unit: mm)
- **Connector**
  - 7-pin SATA male connector
  - 9-pin SATA power connector
- **Shock & Vibration**
  - Shock: 50g (approx.)
  - Vibration: 15g (approx.)
- **RoHS compliant**

*Varies from capacities. The values addressed in the Performance and Power consumption are typical and may vary depending on settings and platforms.
**Only available in 32, 64, 128GB capacities. Please see “Product Ordering Information” for further details.

Table of Contents

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 SAFD drive interfaces with the host allowing data to be seamlessly transferred between the host and the flash devices. **Though built with MLC, this SSD can work in highly demanding environment as it can withstand ambient temperature from -40°C to +85°C (**for certain capacities only**).**

SAFD 18P-M drive is designed with a single-chip controller, offering capacities of up to 256 gigabytes and providing full support for the SATA II high-speed interface standard. It can operate at sustained transfer rates through high bandwidth flash access. The in-chip DMA allows data swap to be highly efficient.

In addition to buffer management through dynamical allocation, SAFD 18P-M adopts Global 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-M provides the S.M.A.R.T. feature that follows the SATA Rev. 2.6 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-M 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.

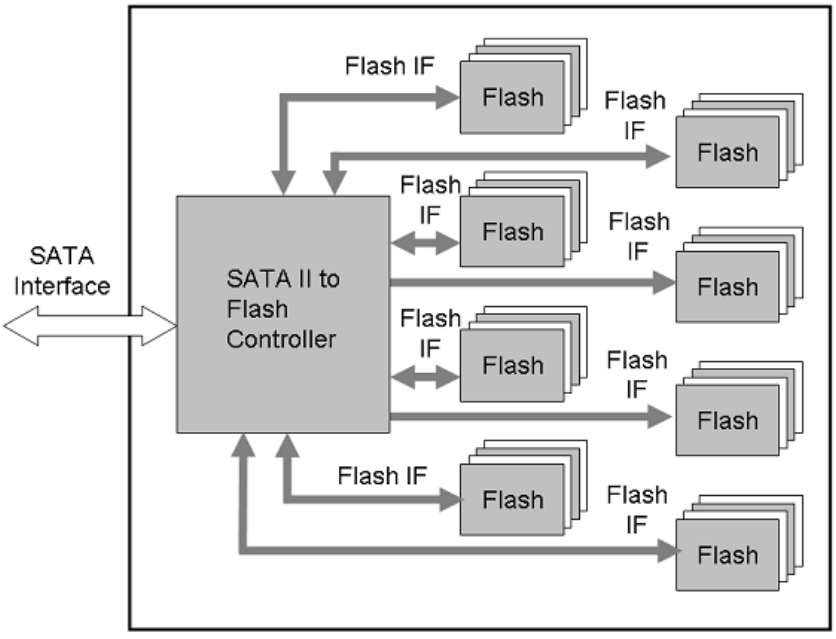


Figure 1-1 Apacer SAFD 18P-M block diagram

1.3 ATA Mode Support

SAFD 18P-M 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 specifications of SAFD 18P-M product family are 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*
16 GB	16,013,942,784	16383	16	63	31,277,232
32 GB	32,017,047,752	16,383	16	63	62,533,296
64 GB	64,023,257,088	16,383	16	63	125,045,424
128 GB	128,035,676,160	16,383	16	63	250,069,680
256 GB	253,437,379,584	16,383	16	63	494,994,882

*Cylinders, heads or sectors are not applicable for these capacities. Only LBA addressing applies.

1.5 Performance

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

Table 1-2 Performance & Random Read/Write 4K specifications

Capacity / Performance	16 GB	32 GB	64 GB	128 GB	256 GB
Sustained Read (MB/s)	200	200	250	250	250
Sustained Write (MB/s)	50	50	80	155	165

Capacity / Random R/W	16 GB	32 GB	64 GB	128 GB	256 GB
Random Read 4K (IOPS)	4275	4275	4200	4131	4224
Random Write 4K (IOPS)	1932	1932	2063	4142	4285

Note: Performances vary from flash configurations.

1.6 Pin Assignments

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

Figure 1-2 SATA Connectors

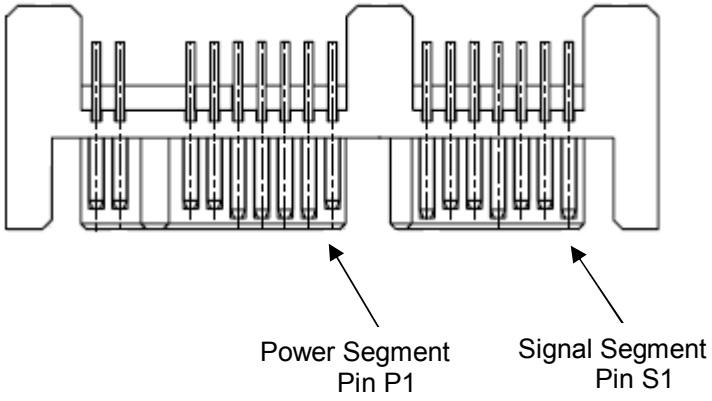


Table 1-3 Signal segment

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

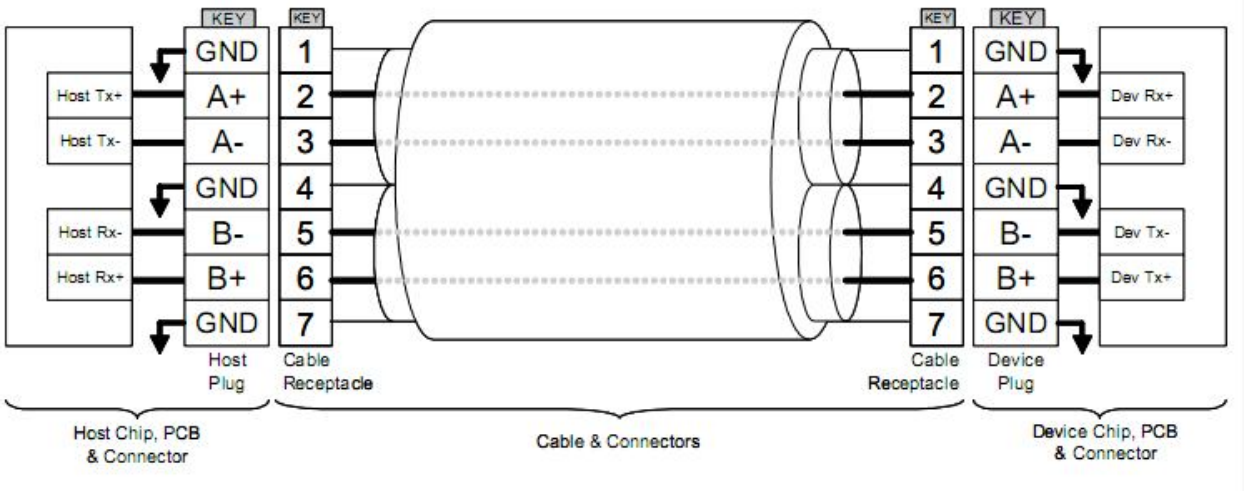


Figure 1-3 SATA Cable/Connector Connection Diagram

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-M.

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 SMART feature that complies with the ATA/ATAPI-7 specifications. Based on the SFF-8035i Rev. 2.0 specifications, Apacer SMART defines vendor-specified SMART Attribute IDs (A0 ~ A5, and 0C). They represent Initial bad block count, Bad block count, Spare block count, Maximum erase count, Average erase count and Power cycle. When the Apacer SMART 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-M 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 Bad Block Management

Although bad blocks on the flash media are already identified by the flash manufacturer, they can also be accumulated over time during operation. SAFD 18P-M's controller maintains a table that lists those normal blocks with disk data, the free blocks for wear leveling, and bad blocks with errors. When a normal block is detected broken, it is replaced with a free block and listed as a bad block. When a free block is detected broken, it is then removed from the free block list and marked as a bad block.

During device operation, this ensures that newly accumulated bad blocks are transparent to the host. The device will stop file write service once there are only two free blocks left such that the read function is still available for copying the files from the disk into another.

3.3 Wear Leveling

The NAND flash devices are limited by a certain number of write cycles. When using a FAT-based file system, frequent FAT table updates are required. If some area on the flash wears out faster than others, it would significantly reduce the lifetime of the whole SSD, even if the erase counts of others are far from the write cycle limit. Thus, if the write cycles can be distributed evenly across the media, the lifetime of the media can be prolonged significantly. This scheme is called wear leveling.

Apacer's wear-leveling scheme is achieved both via buffer management and Apacer-specific global wear leveling. They both ensure that the lifetime of the flash media can be increased, and the disk access performance is optimized as well.

3.4 Power Failure Management

The Low Power Detection on the controller initiates crucial data saving before the power supplied to the device is too low. This feature prevents the device from crash and ensures data integrity during an unexpected power-off.

3.5 ATA Secure Erase

Accomplished by the Secure Erase (SE) command, which added to the open ANSI standards that control disk drives, "ATA Secure Erase" is built into the disk drive itself and thus far less susceptible to malicious software attacks than external software utilities. It is a positive easy-to-use data destroy command, amounting to electronic data shredding. Executing the command causes a drive to internally completely erase all possible user data. This command is carried out within disk drives, so no additional software is required. Once executed, neither data nor the erase counter on the device would be recoverable, which blurs the accuracy of device lifespan. The process to erase will not be stopped until finished while encountering power failure, and will be continued when power is back on.

4. Reliability Specifications

4.1 Environments

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

Table 4-1 SAFD 18P-M environmental specifications

Environment	Specification
Temperature	0°C to 70°C (Operating – Standard), -40 ~ +85℃ (Operating-extended)
	-40°C to 100°C (Non-operating)
Humidity	5% to 95% RH (Non-condensing)
Vibration	Sine wave : 5~55~5 Hz (X, Y, Z) Random : 10-2000 Hz, 16.3 G (X, Y, Z)
Shock – Operating	Acceleration: 1,500 G, 0.5 ms Peak acceleration: 50 G, 11 ms
Altitude	80,000 ft

*Extended Temperature specification is only available in 32, 64, 128GB capacities.

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. Although many component MTBFs are given in databases and often these values are not really accurate, the prediction result for SAFD 18P-M is more than 1,000,000 hours.

Notes about the MTBF:

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

4.3 Endurance

The endurance of a storage device is predicted by TBW (Total Bytes Written) based on several factors related to usage, such as the amount of data written into the drive, block management conditions, and daily workload for the drive. These factors can estimate the lifespan of the drive, by averaging the amount of data written into the SSD in a daily basis. The endurance of our devices is estimated by the following:

The lifetime and TBW of the device are listed in the following table.

Capacity	Host Write (GB)	TBW (TB)
16 GB	9393.79	9.39
32 GB	18787.58	18.78
64 GB	37575.17	37.57
128 GB	75150.35	75.15
256 GB	150300.71	150.30

Notes:

- The measurement assumes the data written to the SSD for test is under a typical and constant rate.

- The measurement follows the standard metric: 1 TB (Terabyte) = 1000 GB.
- The TBW are estimates measured by JEDEC standard but may vary in real world applications due to flash configurations or various platform settings.
- According to JEDEC standard test method, the workload shall be distributed across the SSD and shall achieve that 50% of accesses to 1st 5% of user LBA space, 30% of accesses to next 15% of user LBA space, and 20% of accesses to remainder of user LBA space.

4.4 Certification and Compliance

SAFD 18P-M 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-M.

Table 5-1 SAFD 18P-M operating voltage

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

5.2 Power Consumption

The following table displays the power consumption information for capacities of SAFD 18P-M.

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

Capacity / Mode	16 GB	32 GB	64 GB	128 GB	256 GB
Active Mode (mA)	470	472	540	790	819
Idle Mode (mA)	190	194	197	206	206

Note: power consumption may vary depending on flash configuration or platforms.

5.3 Electrostatic Discharge

Electrostatic discharge

Item	Amount of Discharge	Voltage	Required Criteria	Complied To Criteria (A,B,C)
Air Discharge	10	+8kV	B	A
	10	-8kV	B	A
Contact Discharge	25	+4kV	B	A
	25	-4kV	B	A
Indirect Discharge (HCP)	25	+4kV	B	A
	25	-4kV	B	A
Indirect Discharge (VCP Front)	25	+4kV	B	A
	25	-4kV	B	A
Indirect Discharge (VCP Left)	25	+4kV	B	A
	25	-4kV	B	A
Indirect Discharge (VCP Back)	25	+4kV	B	A

	25	-4kV	B	A
Indirect Discharge (VCP Right)	25	+4kV	B	A
	25	-4kV	B	A

5.4 Electrical Fast Transient/Burst

Electrical Fast Transient/Burst

Inject Line	Polarity	Voltage kV	Inject Time (Second)	Inject Method	Required Criteria	Complied to Criteria
L-N-PE	±	1kV	60	Direct	B	A

Notes about Electrostatic Discharge & Electrical Fast Transient/Burst

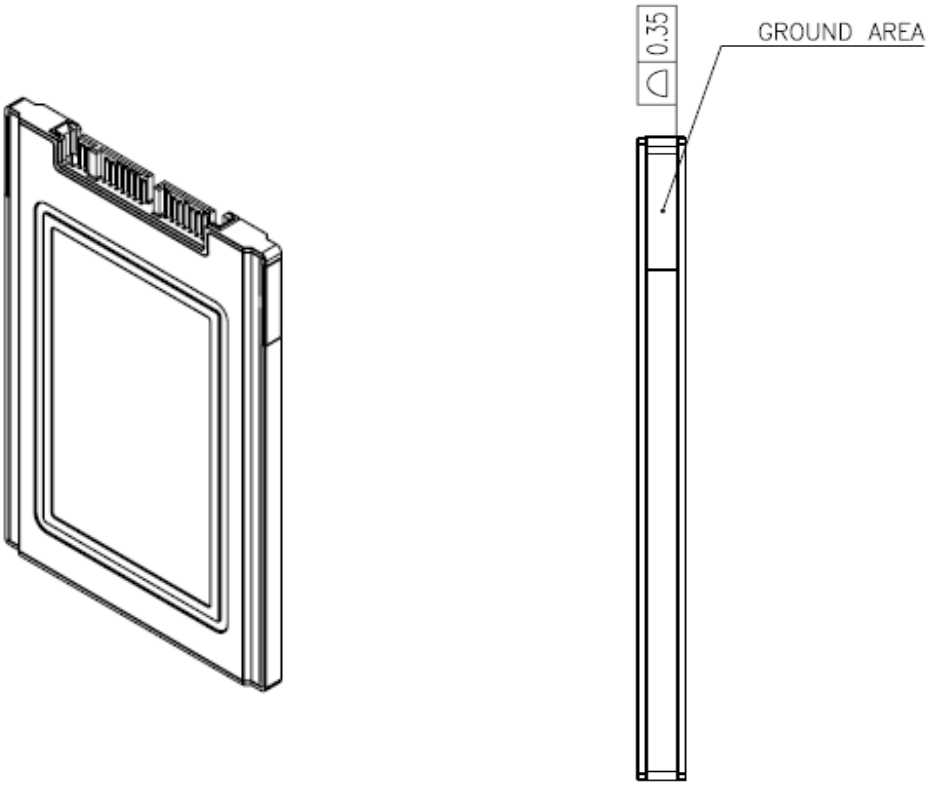
The tests performed are from lowest level up to the highest level as required by standard, but only highest level is shown on the report.

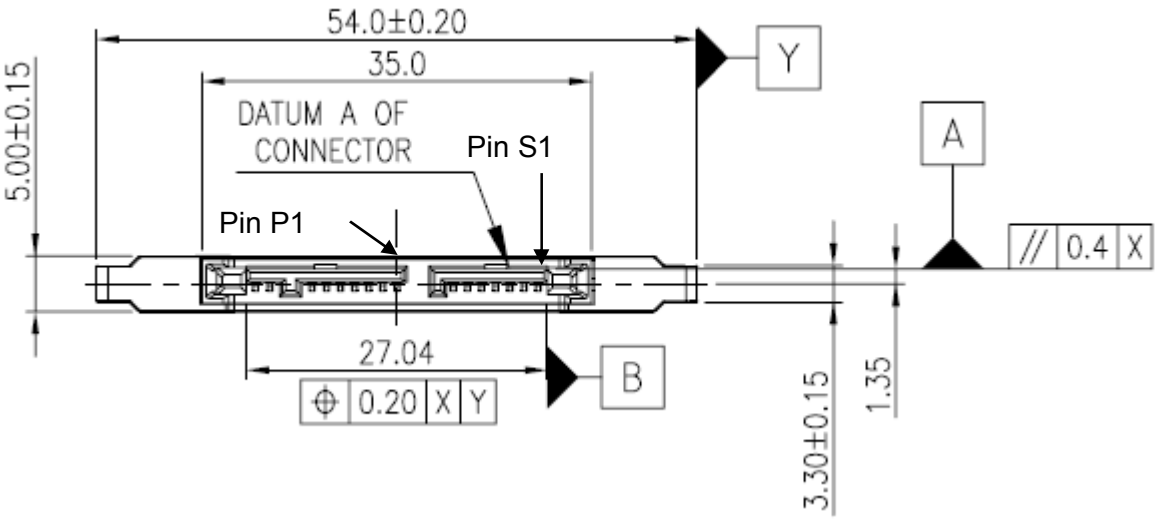
Meet criteria A: Operate as intended during and after the test
Meet criteria B: Operate as intended after the test
Meet criteria C: Loss/Error of function

Additional Information:
EUT stopped operation and could / could not be reset by operator at kV.
No false alarms or other malfunctions were observed during or after the test.

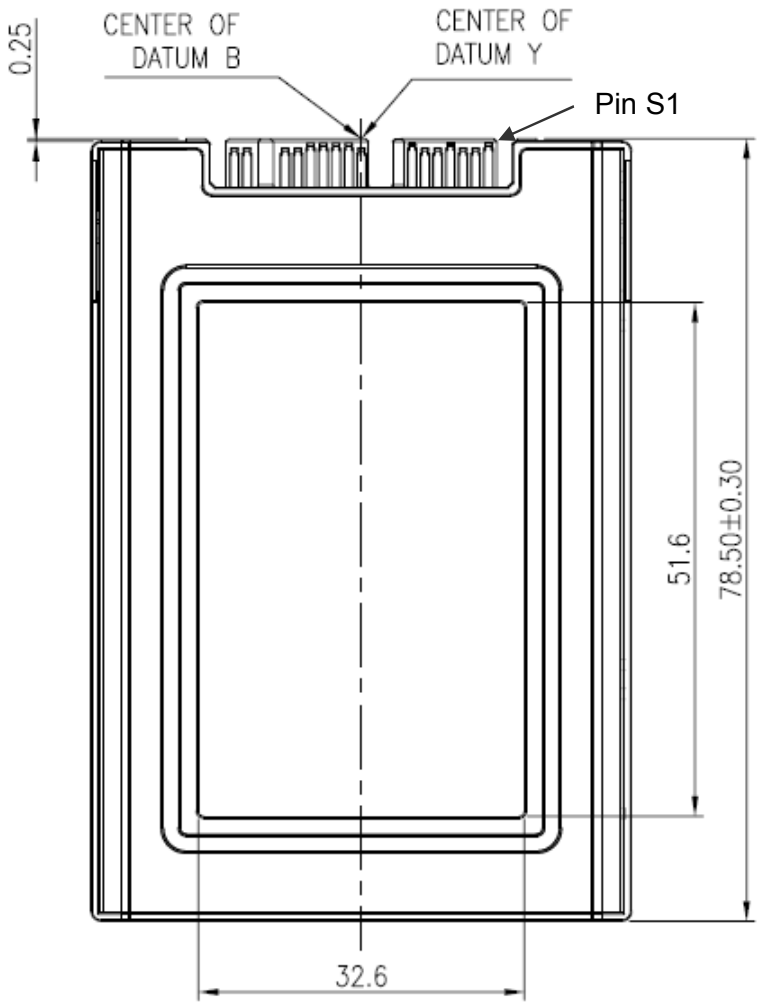
The Contact discharges were applied at least total 200 discharges at a minimum of four test points.

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 – C CM X X

Voltage
Blank: 5V
L: 3.3V

Temperature Range
Blank: Standard
W: Extended Temperature

Flash Type

Version Control

Capacities:

016G:	16GB
032G:	32GB
064G:	64GB
128G:	128GB
256G:	256GB

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
16 GB	APS18P6A016G-CCM	--
32 GB	APS18P6A032G-CCM	APS18P6A032G-CCMW
64 GB	APS18P6A064G-CCM	APS18P6A064G-CCMW
128 GB	APS18P6A128G-CCM	APS18P6A128G-CCMW
256 GB	APS18P6A256G-CCM	--

SAFD18P (voltage: 3.3V)

Capacity	Standard	Extended Temperature
16 GB	APS18P6A016G-CCML	--
32 GB	APS18P6A032G-CCML	APS18P6A032G-CCMWL
64 GB	APS18P6A064G-CCML	APS18P6A064G-CCMWL
128 GB	APS18P6A128G-CCML	APS18P6A128G-CCMWL
256 GB	APS18P6A256G-CCML	--

Note: Valid combinations are those products in mass production or will be in mass production. Consult your Apacer sales representative to confirm availability of valid combinations and to determine availability of new combinations.

Revision History

Revision	Description	Date
0.1	Preliminary release	01/19/2010
1.0	Official release	08/05/2011
1.1	Version updates ■ Corrected power consumption ■ Added information about electrostatic discharge and electrical fast transient/burst ■ Added information about shock and vibration on the Feature page ■ Temperatures in Fahrenheit are added on the Feature page	11/07/2011
1.2	Version updates ■ Updated performance and power consumption ■ Updated address for our European base ■ Updated POI	11/11/2011
1.3	Version updates ■ Extended operating temperature	11/30/2011
1.4	Version updates ■ Revised S.M.A.R.T information	03/23/2012
1.5	Version updates ■ Added Endurance sub-section ■ Added Random read/write 4K data	05/03/2012

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