

RoHS Compliant

Serial ATA Flash Drive

Specifications for SAFD 181

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Version 1.3



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Features:

- **Standard Serial ATA 2.5 (Gen. 2)**
 - Serial ATA 2.5 (Gen. 2)
 - SATA II, 3.0 Gbps
 - ATA-compatible command set
- **Capacities**
 - 8, 16, and 32 GB
- **Performance**
 - Burst read/write: 300 MB/sec
 - Sustained read: up to 160 MB/sec
 - Sustained write: up to 135 MB/sec
- **Intelligent endurance design**
 - Built-in hardware ECC, enabling up to 8/15 bit correction per 512 bytes
 - Global 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
 - Power Failure management
 - Quick Erase
 - S.M.A.R.T. technology
- **NAND Flash Type: SLC**
- **Zero power data retention**
 - No battery required for data storage
- **Temperature ranges**
 - Operation:
 - Standard: 0°C to 70°C
 - Extended Temperature: -40°C to 85°C
 - Storage: -40°C to 100°C
- **Supply voltage**
 - 3.3 V $\pm$ 5%
- **Low power consumption**
 - Active mode: 400 mA (Max)
 - Idle mode: 216 mA
- **Form factor**
 - 1.8 inch
- **Connector**
 - 7-pin SATA male connector
 - 9-pin SATA power connector
- **RoHS compliant**

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1. Product Description

1.1 Introduction

Apacer's SAFD 181 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.

The SAFD 181 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 100 megabytes per second, which is much faster than any other solid-state or traditional SATA drive currently available on the market.

In addition to buffer management through dynamical allocation, the SAFD 181 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. The SAFD 181 provides the S.M.A.R.T. feature that follows the SATA Rev. 2.5, 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

The SAFD 181 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.

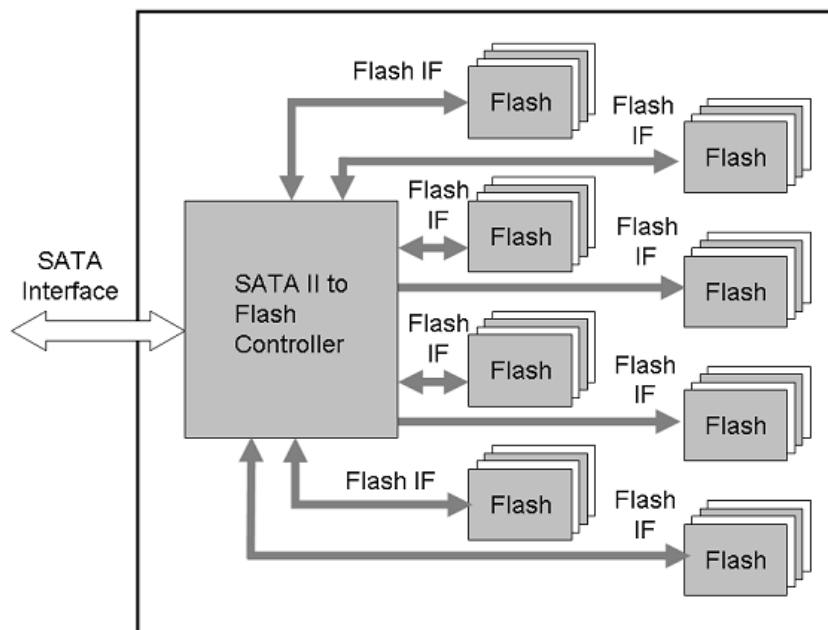


Figure 1-1 Apacer SAFD 181 block diagram

1.3 ATA Mode Support

The SAFD 181 provides ATA mode support as follows:

- Up to PIO mode-4
- Up to Multiword DMA mode-2
- Up to UDMA mode-5

1.4 Capacity Specification

Capacity specification of the SAFD 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	8,061,419,520	15620	16	63	15,744,960
16 GB	16,139,681,792	16383	16	63	31,522,816 ¹
32 GB	32,296,140,800	16383	16	63	63,078,400 ¹

¹ Cylinders, heads or sectors are not applicable for these capacities. Only LBA addressing applies.

1.5 Performance

Performance of the SAFD is shown in Table 1-2.

Table 1-2 Performance specification

Capacity Performance	8GB	16GB	32GB
Sustained Read (MB/s)	155	159	155
Sustained Write (MB/s)	106	106	136

1.6 Pin Assignments

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

Figure 1-2 Micro-SATA Connectors

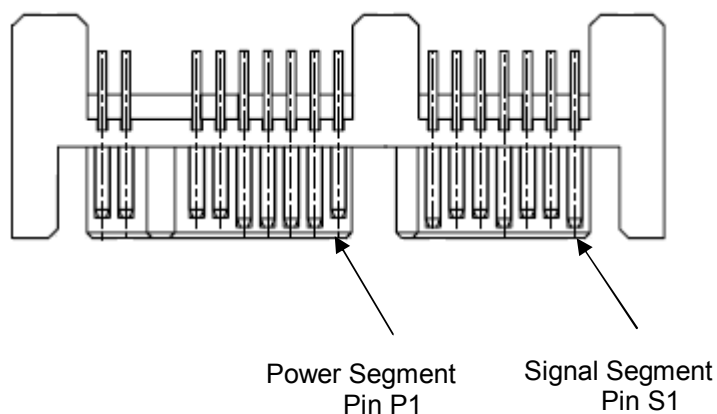


Table 1-3: Signal segment

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

2. Software Interface

2.1 Command Set

Table 2-1 summarizes the ATA commands supported by the SAFD 181.

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

3. Flash Management

3.1 Error Correction/Detection

The SAFD181 implements a hardware ECC scheme, based on the BCH algorithm, to achieve up to 8/15 bit correction per 512 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. The controller of SAFD181 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 cached data saving before the power supply to the device is too low. This feature prevents the device from crash and ensures data integrity during an unexpected blackout. Once power was failure before cached data writing back into flash, data in the cache will lost. The next time the power is on, the controller will check these fragmented data segment, and, if necessary, replace them with old data kept in flash until programmed successfully.

3.5 Quick Erase

Accomplished by the Secure Erase (SE) command, which added to the open ANSI standards that control disk drives, "Quick 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.

3.6 S.M.A.R.T. Technology

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 SMART feature follows the SATA Rev. 2.5, ATA/ATAPI-7 specifications, using the standard SMART command B0h to read data from the drive. And based on the SFF-8035i Rev. 2.0 specifications, Apacer SMART defines 3 vendor-specified SMART Attribute IDs (E5h, E8h-EFh, and F3h) in the SAFD181. They represent Flash ID, good block count, free-list block count, maximum erase count, average erase count, and firmware version information. When the Apacer SMART Utility running on the host, it analyzes and reports the disk status to the host before the SAFD181 is in critical condition.

4. Environmental Specifications

4.1 Environments

The SAFD 181 environmental specifications follow the US Military Standard MIL-STD-810F, as shown in Table 4-1.

Table 4-1 SAFD 181 environmental specifications

Environment	Specification
Temperature	0°C to 70°C (Standard) ; -40°C to 85°C (Extended Temperature)
	-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

4.2 Mean Time Between Failures (MTBF)

Mean Time Between Failures (MTBF) is predicted based on reliability data for the individual components in the SAFD drive. Although many component MTBFs are given in databases and often these values are not really accurate, the prediction result for the SAFD 181 is more than 2,000,000 hours.

4.3 Certification and Compliance

The SAFD 181 drive complies with the following standards:

- CE – EN55022/55024
- FCC 47CFR Part15 Class B
- RoHS
- MIL-STD-810F
- SATA II (SATA Rev. 2.5)
- Up to ATA/ATAPI-7 (including S.M.A.R.T.)

5. Electrical Characteristics

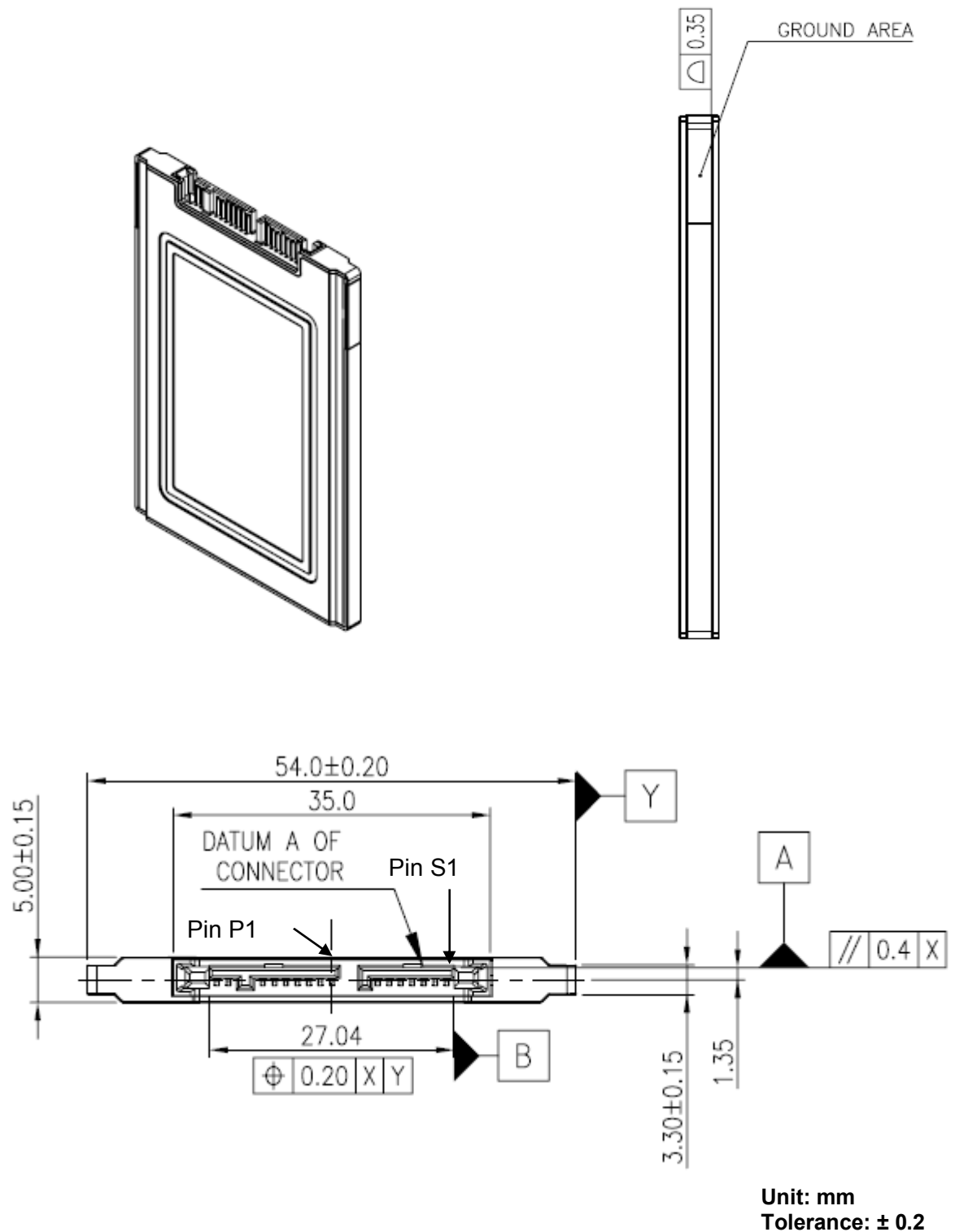
5.1 Operating Voltage

Table 5-1 lists the supply voltage for SAFD 181.

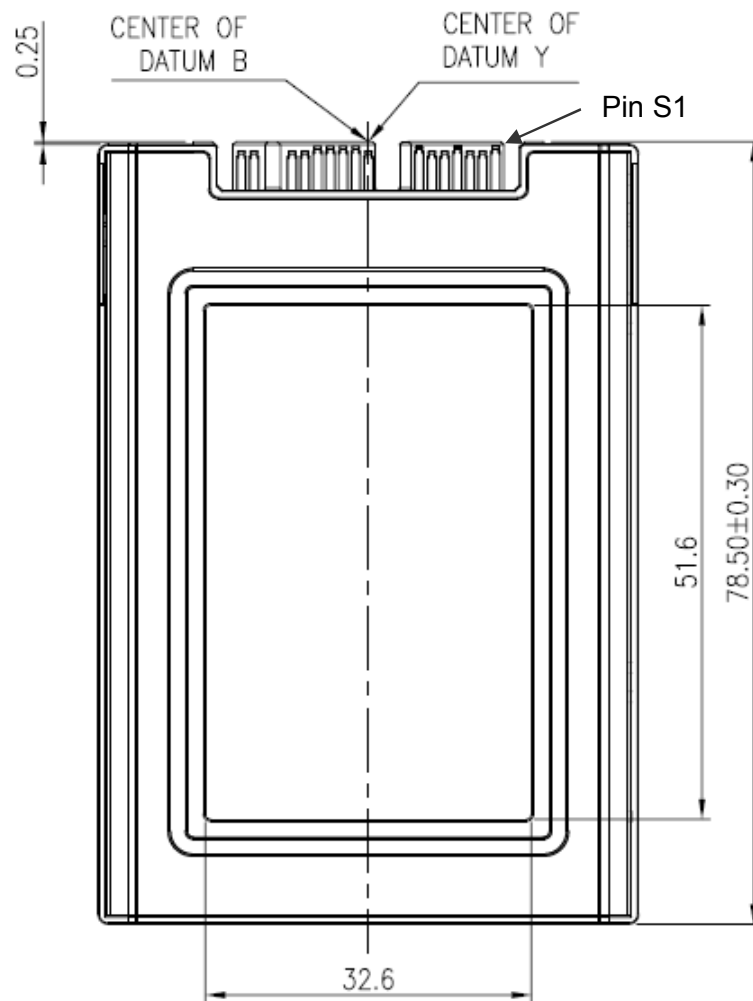
Table 5-1 SAFD 181 operating voltage

Parameter	Conditions
Supply voltage	3.3V $\pm$ 5% (3.135-3.465 V)

6. Physical Characteristics



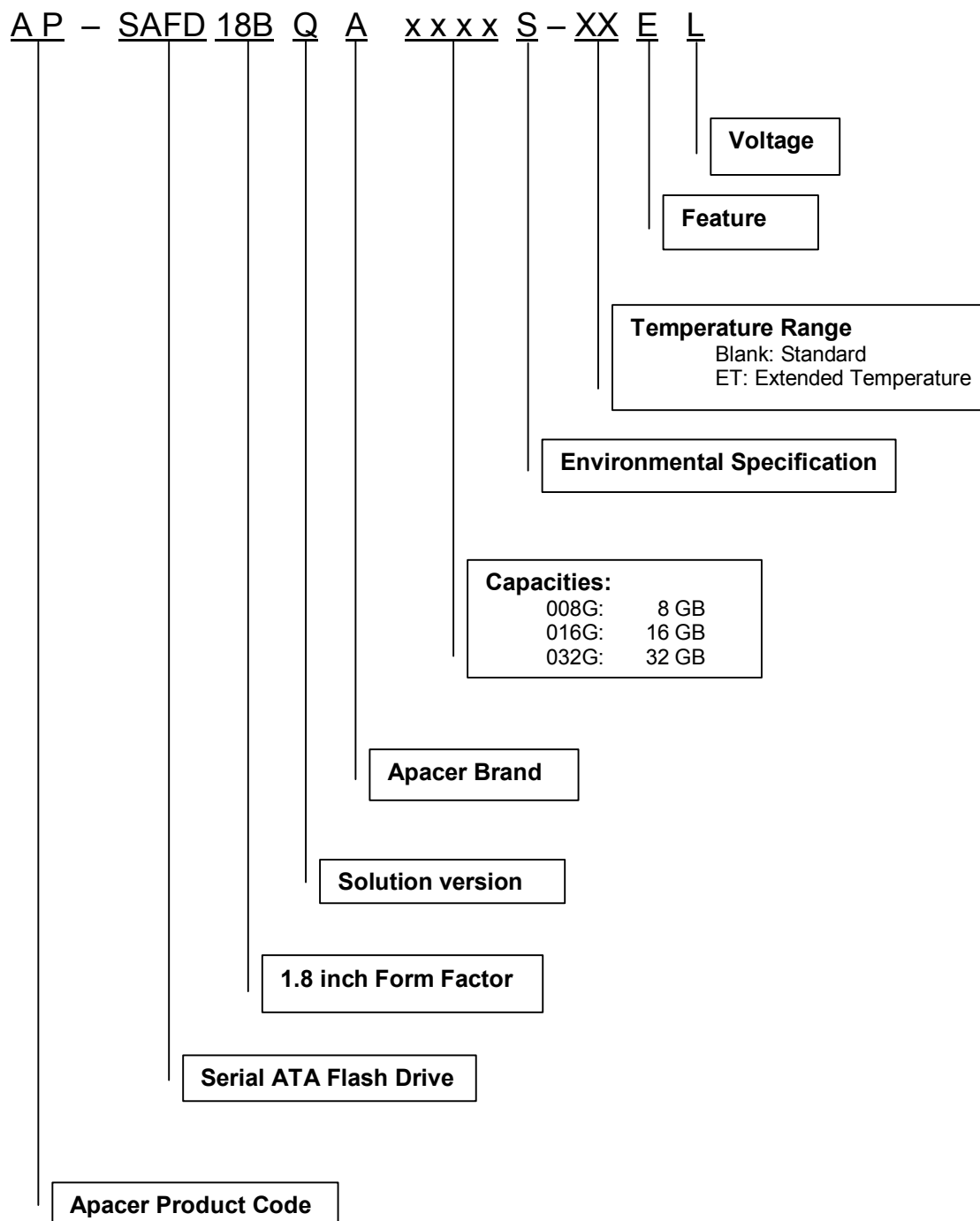
Serial ATA Flash Drive
AP-SAFD18BQxxxxS-XXEL



Unit: mm
Tolerance: ± 0.2

7. Product Ordering Information

7.1 Product Code Designations



7.2 Valid Combinations

SAFD181 Capacity	Standard	Extended Temperature
8 GB	AP-SAFD18BQA008GS-EL	AP-SAFD18BQA008GS-ETEL
16 GB	AP-SAFD18BQA016GS-EL	AP-SAFD18BQA016GS-ETEL
32 GB	AP-SAFD18BQA032GS-EL	AP-SAFD18BQA032GS-ETEL

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	Mar. 12, 2009
0.2	Updated performance & product code designation	Mar. 26, 2009
0.3	Updated command sets & quick erase section	Apr. 9, 2009
1.0	Official release	May 27, 2009
1.1	Updated feature item	Aug. 21, 2009
1.2	Updated Apacer Memory America, Inc. contact number	Sep. 29, 2009
1.3	Updated product ordering information	Dec. 17, 2009

Global Presence

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