RoHS Compliant

Value Added ATA Flash Drive Ⅲ

Specifications for AFDⅢ 183

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Version 1.5

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Features:

- **Standard ATA/IDE bus interface**
  - ATA command set compatible
  - ATA operating mode supports up to:
    PIO Mode-4
    Multiword DMA Mode-2
    Ultra DMA Mode-4
- **Connector type**
  - 40-pin ZIF
- **Power consumption (typical)***
  - Supply voltage: 3.3V
  - Active mode: 75mA
  - Sleep mode: 2000µA
- **Performance***
  - Sustained read: Up to 21 MB/sec
  - Sustained write: Up to 18 MB/sec
- **Capacity**
  - 1, 2, 4, 8, 16, 32 GB
- **NAND Flash Type: SLC**
- **Endurance (TBW: Terabytes Written)**
  - 1 GB: 27.4 TBW
  - 2 GB: 45.5 TBW
  - 4 GB: 54.7 TBW
  - 8 GB: 80.6 TBW
  - 16 GB: 129.8 TBW
  - 32 GB: 223.0 TBW
- **Temperature ranges**
  - Operating:
    Standard: 0℃ to 70℃
    Extended: -40℃ to 85℃
  - Storage: -40℃ to 100℃
- **Flash management**
  - Advanced wear-leveling algorithms
  - S.M.A.R.T. technology
  - Built-in hardware ECC
  - Flash block management
  - Power failure management
  - ATA Security Erase
- **Form factor**
  - 1.8” ATA Flash Drive
  - Dimensions: 71.00x54.00x5.00, unit: mm
- **Shock & Vibration****
  - Shock: 1,500 G
  - Vibration: 15 G
- **RoHS compliant**

*Varies from capacities. The values addressed for Performance and Power consumptions are typical and may vary depending on settings and platforms.
**Non-operating

Table of Contents

1. General Description

Apacer's ATA-Flash Drive (AFD) is a high-performance, solid state drive (SSD) designed to replace a conventional ATA hard disk drive. AFD supports standard ATA/IDE protocol and can be plugged into a standard ATA/IDE connector commonly found in desktop or portable PCs. It is more rugged, reliable and power-efficient compared to the mechanical hard drive and is designed for use in rugged laptops, military devices, thin clients, Point of Sale (POS) terminals, telecom, medical instruments, surveillance systems and industrials PCs. AFD also offers users selectable Master/Slave operation through an external jumper setting. Apacer AFD Series is the best instant replacement for high-maintenance HDD where reliability is a major concern.

AFD includes a built-in microcontroller and file management firmware that communicates through with the ATA standard interfaces. AFD is designed to work at 5 Volts, support the standard ATA/IDE protocol up to PIO Mode-4, Multiword DMA Mode-2, and Ultra DMA Mode-6 interfaces, and use a standard ATA driver that fits to most of the mainstream operating systems. Featuring technologies as Advanced Wear-leveling algorithms, S.M.A.R.T, Flash Block Management, Power Failure Management,Implements d and ATA Secure Erase, the AFD device assures users of security in storage applications.

2. Functional Block

The ATA-Flash Drive (AFD) includes the ATA controller and flash media, as well as the ATA standard interface. Figure 2-1 shows the functional block diagram.

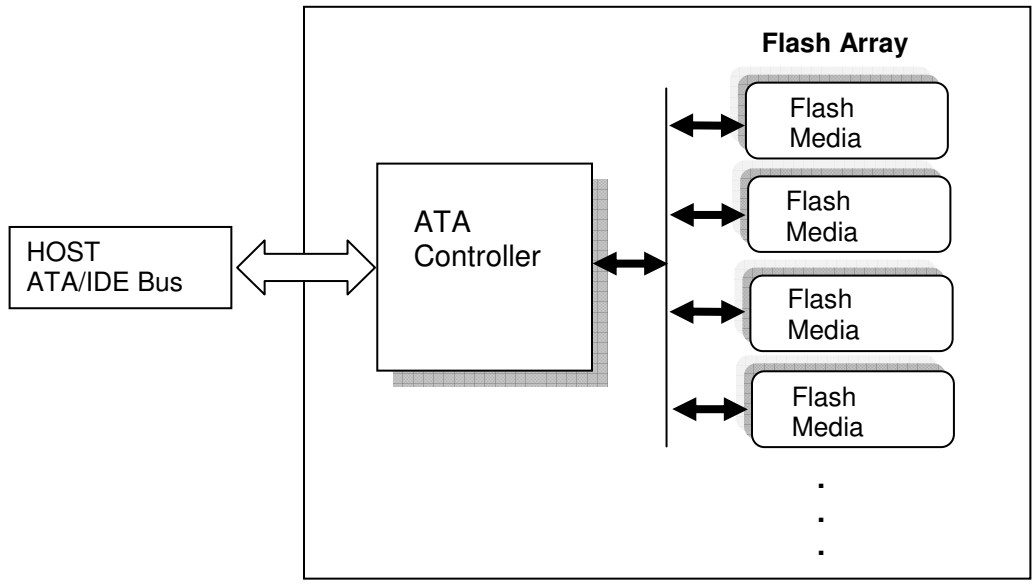


Figure 2-1: Functional block diagram

3. Pin Assignments

Table 3-1 lists the pin assignments with respective signal names for the 40-pin configuration. A "#" suffix indicates the active low signal. The pin type can be input, output or input/output.

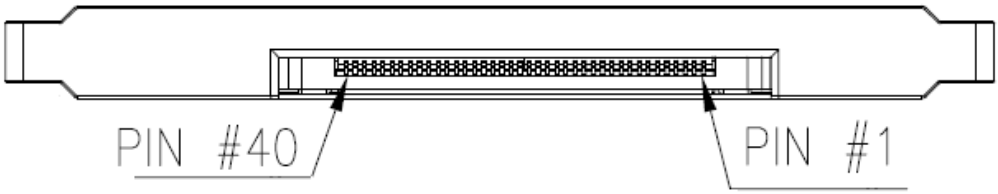


Table 3-1: Pin assignment

Pin No.	SIGNALS	Pin No.	SIGNALS
1	Reserved	21	GROUND
2	Reserved	22	DMARQ
3	RESET#	23	GROUND
4	GROUND	24	DIOW#
5	DD 7	25	DIOR#
6	DD 8	26	GROUND
7	DD 6	27	IORDY
8	DD 9	28	GROUND
9	DD 5	29	DMACK#
10	DD 10	30	INTRQ
11	DD 4	31	A1
12	DD 11	32	PDIAG#
13	DD 3	33	A0
14	DD 12	34	A2
15	DD 2	35	CS0#
16	DD 13	36	CS1#
17	DD 1	37	DASP#
18	DD 14	38	3.3V
19	DD 0	39	3.3V
20	DD 15	40	CSEL

4. Product Specifications

4.1 Capacity

Capacity specification of the ATA-Flash Drive (AFD) product family is available in Table 4-1. It lists the specific capacity and the default numbers of cylinder heads, sectors and cylinders for each product line.

Table 4-1: Capacity specification

Capacity	Total bytes	Cylinders	Heads	Sectors	Max LBA
1GB	1,024,966,656	1986	16	63	2,001,888
2GB	2,048,385,024	3969	16	63	4,000,752
4GB	4,096,253,952	7937	16	63	8,000,496
8GB	8,001,552,384	15504	16	63	15,628,032
16 GB	16,001,040,384	16383	16	63	31,252,032[1]
32 GB	32,001,048,576	16383	16	63	62,502,048[1]

*Display of total bytes varies from file systems. 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.

4.2 Performance

Performance of the ATA-Flash Disk is listed in Table 4-2.

Table 4-2: Performance specifications

Capacity / Performance	1 GB	2 GB	4 GB	8 GB	16 GB	32 GB
Sustained read (MB/s)	21	20	21	20	20	21
Sustained write (MB/s)	12	11	11	11	11	18

Note: Performances vary from flash configurations or host system settings.

4.3 Environmental Specification

Environmental specification of the ATA-Flash Drive follows the MIL-STD-810F standards as shown in Table 4-3.

Table 4-3: ATA-Flash Drive environmental specifications

Environment		Specification
Temperature	Operation	0℃ to 70℃; -40℃ to 85℃ (Extended)
	Storage	-40℃ to 100℃
Vibration (Non-Operating)		Sine wave: 10~2000Hz, 15G (X, Y, Z axes)
Shock (Non-Operating)		Half sine wave, 1500G, 0.5msec (X, Y, Z ; All 6-axis)

4.4 Endurance

The endurance of a storage device is predicted by TeraBytes 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. Thus, key factors, such as Write Amplifications and the number of P/E cycles, can influence the lifespan of the drive.

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

Capacity	TeraBytes Written
1 GB	27.4
2 GB	45.5
4 GB	54.7
8 GB	80.6
16 GB	129.8
32 GB	223.0

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.

5. Flash Management

5.1. Advanced wear-leveling algorithms

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.

5.2 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 adopts the standard SMART command B0h to read data from the drive. When the Apacer SMART Utility running on the host, it analyzes and reports the disk status to the host before the device is in critical condition.

5.3 Built-in hardware ECC

The ATA-Disk Module uses BCH Error Detection Code (EDC) and Error Correction Code (ECC) algorithms which correct up to eight random single-bit errors for each 512-byte block of data. High performance is fulfilled through hardware-based error detection and correction.

5.4 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.

5.5 Power Failure Management

Power Failure Management plays a crucial role when experiencing unstable power supply. Power disruption may occur when users are storing data into the SSD. In this urgent situation, the controller would run multiple write-to-flash cycles to store the metadata for later block rebuilding. This urgent operation requires about several milliseconds to get it done. At the next power up, the firmware will perform a status tracking to retrieve the mapping table and resume previously programmed NAND blocks to check if there is any incompleteness of transmission.

5.6 ATA Security 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.

6. Software Interface

6.1 Command Set

This section defines the software requirements and the format of the commands the host sends to the ATA-Flash Drive (AFD). Commands are issued to the AFD by loading the required registers in the command block with the supplied parameters, and then writing the command code to the Command register. The manner in which a command is accepted varies.

Table 6-1: Command set (1 of 2)

Command	Code
Check-Power-Mode	E5H or 98H
Execute-Drive-Diagnostic	90H
Erase Sector(s)	C0H
Flush-Cache	E7H
Format Track	50H
Identify-Drive	ECH
Idle	E3H or 97H
Idle-Immediate	E1H or 95H
Initialize-Drive-Parameters	91H
NOP	00H
Read-Buffer	E4H
Read-DMA	C8H or C9H
Read-Multiple	C4H
Read-Sector(s)	20H or 21H
Read-Verify-Sector(s)	40H or 41H
Recalibrate	1XH
Request-Sense	03H
Security-Disable-Password	F6H
Security-Erase-Prepare	F3H
Security-Erase-Unit	F4H
Security-Freeze-Lock	F5H
Security-Set-Password	F1H
Security-Unlock	F2H
Seek	7XH
Set-Features	EFH

Table 6-1: Command set (2 of 2)

Command	Code
SMART	B0H
Set-Multiple-Mode	C6H
Set-Sleep-Mode	E6H or 99H
Standby	E2H or 96H
Standby-Immediate	E0H or 94H
Translate-Sector	87H
Write-Buffer	E8H
Write-DMA	CAH or CBH
Write-Multiple	C5H
Write-Multiple-Without-Erase	CDH
Write-Sector(s)	30H or 31H
Write-Sector-Without-Erase	38H
Write-Verify	3CH

7. Electrical Specification

Caution: **Absolute Maximum Stress Ratings –** Applied conditions greater than those listed under "Absolute Maximum Stress Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these conditions or conditions greater than those defined in the operational sections of this data sheet is not implied. Exposure to absolute maximum stress rating conditions may affect device reliability.

Table 7-1: Operating range

Standard Operating Temperature	0℃ to +70℃
Extended Operating Temperature	-40℃ to +85℃
Supply voltage	3.3V± 5% (3.135-3.465V)

Table 7-2: Absolute maximum power pin stress ratings

Parameter	Symbol	Conditions
Input Power	V_{DD}	-0.3V min. to 6.5V max.
Voltage on any pin except V_{DD} with respect to GND	V	-0.5V min. to VDD + 0.5V max.

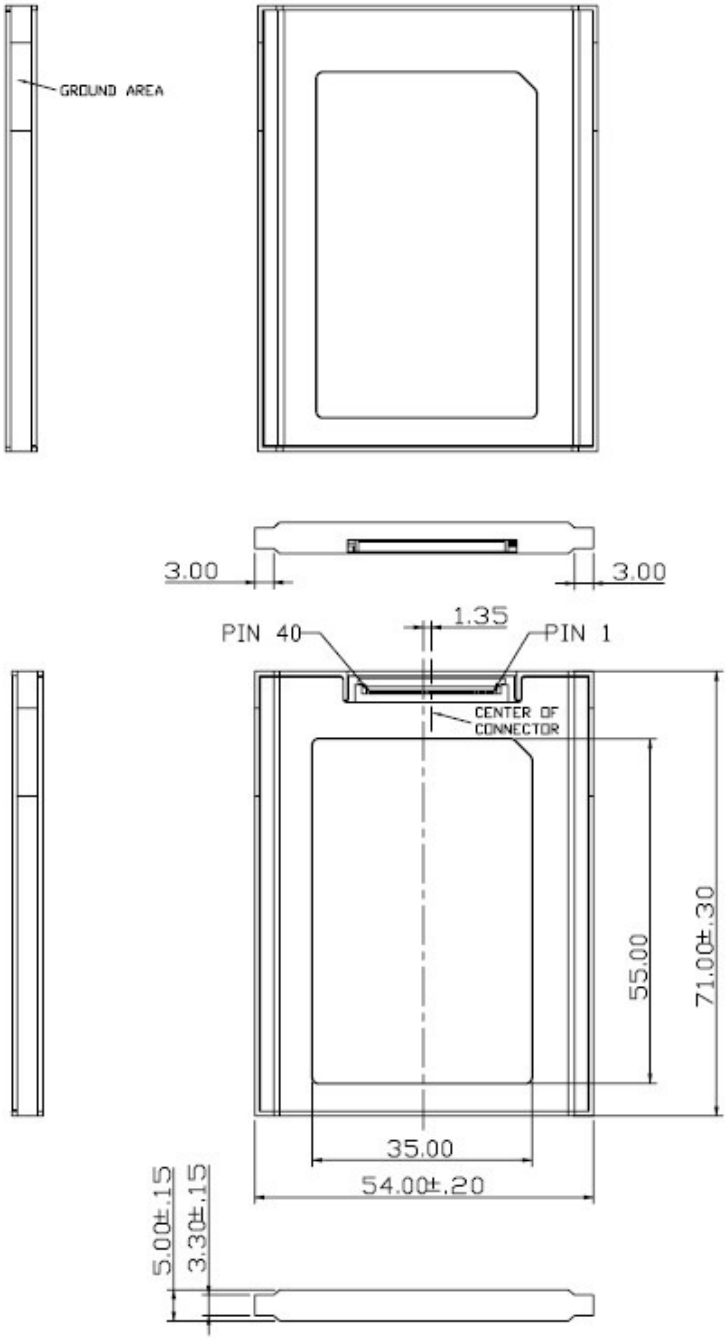
Table 7-3: Recommended system power-up timings

Symbol	Parameter	Typical	Maximum	Units
$T_{PU-READY}$[1]	Power-up to Ready Operation	200	1000	ms
$T_{PU-WRITE}$[1]	Power-up to Write Operation	200	1000	ms

1. This parameter is measured only for initial qualification and after a design or process change that could affect this parameter.

8. Physical Characteristics

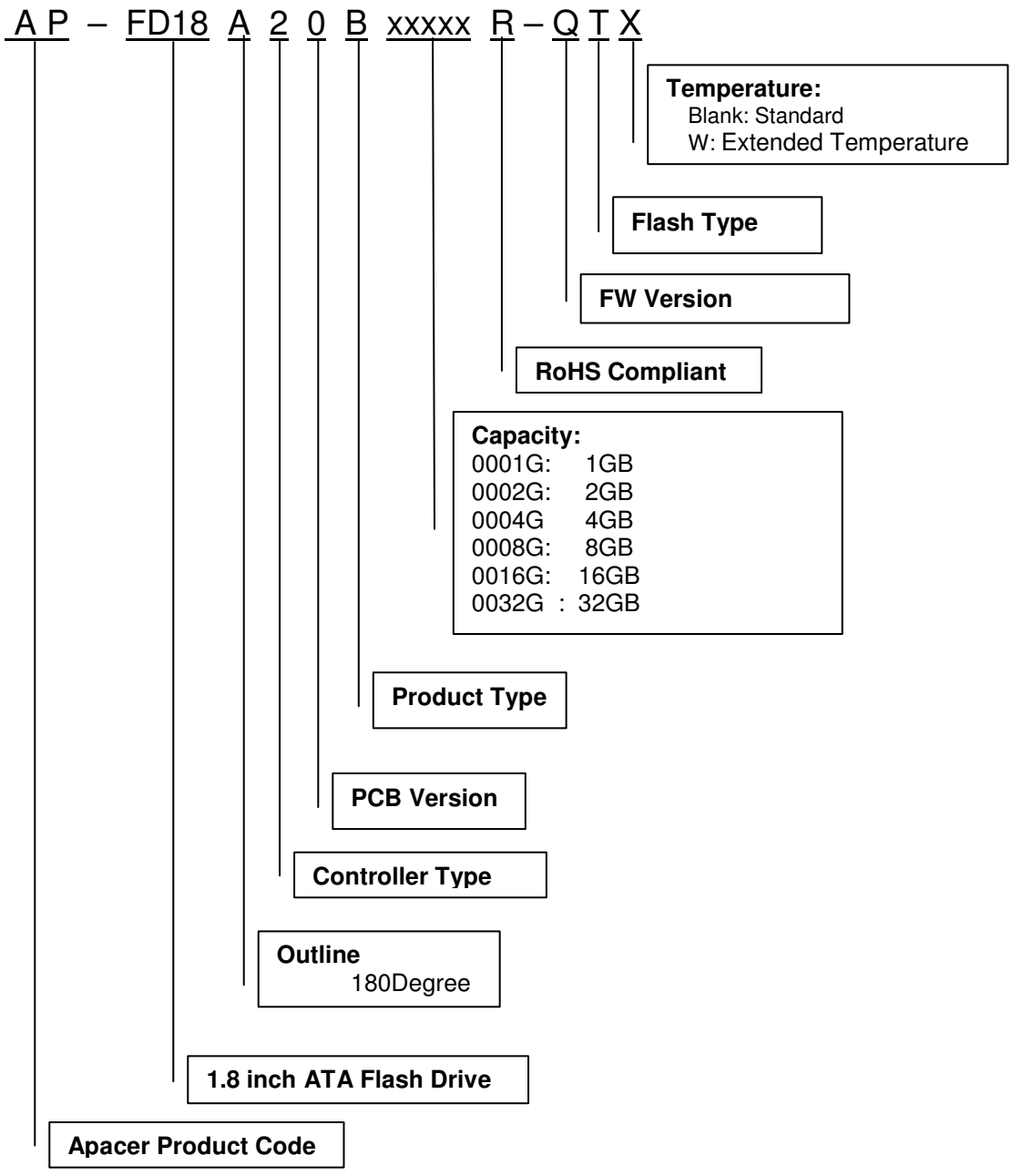
8.1 Dimension



Unit: mm

9. Product Ordering Information

9.1 Product Code Designation



9.2 Valid Combinations

Capacity	Standard	Extended Temperature
1GB	AP-FD18A20B0001GR-QT	AP-FD18A20B0001GR-QTW
2GB	AP-FD18A20B0002GR-QT	AP-FD18A20B0002GR-QTW
4GB	AP-FD18A20B0004GR-QT	AP-FD18A20B0004GR-QTW
8 GB	AP-FD18A20B0008GR-QT	AP-FD18A20B0008GR-QTW
16 GB	AP-FD18A20B0016GR-QT	AP-FD18A20B0016GR-QTW
32 GB	AP-FD18A20B0032GR-QT	AP-FD18A20B0032GR-QTW

Revision History

Revision	Date	Description	Remark
1.0	01/20/2009	Official release	
1.1	02/11/2009	Modified document layout	
1.2	03/18/2011	Updated Performance Specification & Product Ordering Information	
1.3	06/13/2011	Updated Product Ordering Information	
1.4	08/11/2013	Updated performance and product ordering information due to change in NAND flash use Updated the address of Taiwan headquarter Added endurance TBW section to replace MTBF	
1.5	08/26/2013	Modified the performance due to change in flash configurations	

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