

***RoHS Compliant***

***Value Added ATA Flash Drive III***

***Specification for AFD III 183***

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**Version 1.2**



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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
- **Low power consumption (typical)**
  - Supply voltage: 3.3V
  - Active mode: 75mA
  - Sleep mode: 2000µA
- **Performance**
  - Sustained read: Up to 35 MB/sec
  - Sustained write: Up to 15 MB/sec
- **Capacity**
  - 1, 2, 4, 8, 16, 32 GB
- **NAND Flash Type: SLC**
- **Temperature ranges**
  - Operation:
    - Standard: 0°C to 70°C
    - ET<sup>1</sup>: -40°C to 85°C
  - Storage: -40°C to 100°C
- **Flash management**
  - **Intelligent endurance design**
    - Advanced wear-leveling algorithms*
    - S.M.A.R.T. Technology*
    - Built-in Hardware ECC*
    - Enhanced Data Integrity*
  - **Intelligent power failure recovery**
  - **Enhanced security level**
    - Secure Protection Zone*
    - ATA Secure Erase*
- **RoHS compliant**

1. Extended Temperature

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# 1. General Description

Apacer's ATA-Flash Drive (AFD) is a high-performance, solid state drive (SSD) designed to replace a conventional IDE hard disk drive. AFD supports standard ATA/IDE protocol and can be plugged into a ZIF connector commonly found in 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 industrial PCs. Apacer AFD Series is the best drop-in 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 and is set to the Master operation in default. This means the AFD does not require any additional or proprietary host software such as the Flash File System (FFS) and Memory Technology Driver (MTD) software. AFD is designed to work at 3.3 Volts, support the standard ATA/IDE protocol up to PIO Mode-4, Multiword DMA Mode-2, and Ultra DMA Mode-4 interfaces and uses a standard ATA driver that fits to all major operating systems such as Microsoft's Windows series, MAC OS, and UNIX variants.

Featuring technologies as Advanced Wear-leveling algorithms, S.M.A.R.T, Built-In Hardware ECC, Enhanced Data Integrity, Intelligent Power Failure Recovery, Secure Protection Zone and ATA Secure Erase, Apacer's AFD assures users of a versatile device on data storage.

## 1.1 Performance-Optimized Controller

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The heart of an ATA-Flash Drive is the ATA controller, which translates standard ATA signals into the Flash Media data and controls of the flash media. This proprietary ATA controller is specifically designed to attain high data throughput from the host to the flash.

### 1.1.1 Power Management Unit (PMU)

The power management unit (PMU) controls the power consumption of the ATA-Flash Drive. It reduces the power consumption of the ATA-Flash Drive Controller by putting circuitry not in operation into sleep mode. The PMU has zero wake-up latency.

### 1.1.2 SRAM Buffer

The ATA Flash Drive Controller performs as an SRAM buffer to optimize the host's data transfer to and from the flash media.

## 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.

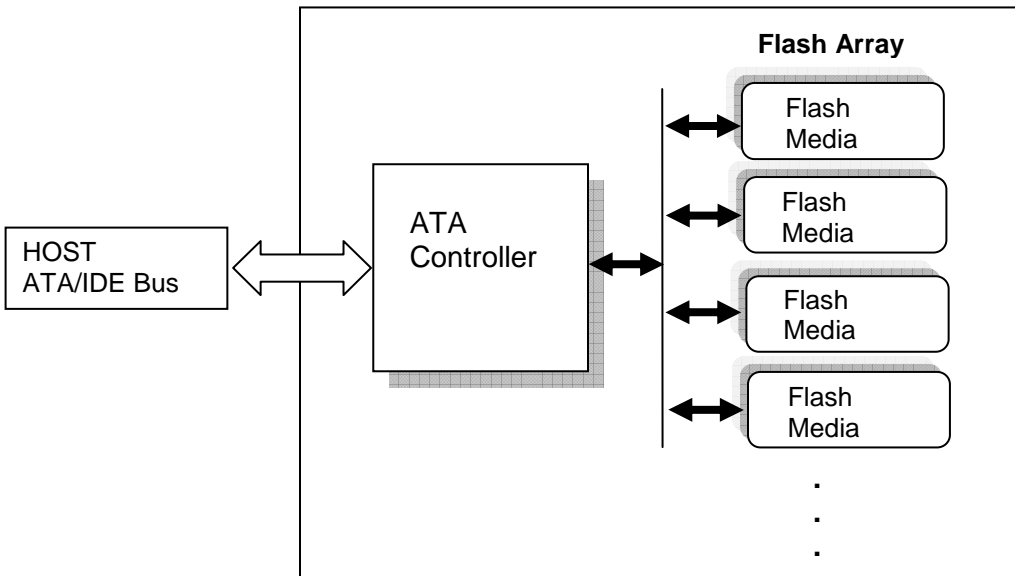
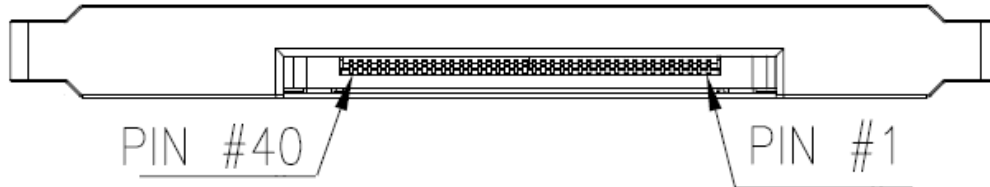


Figure 2-1: Functional block diagram

### 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. Capacity Specification

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 <sup>1</sup>
32 GB	32,001,048,576	16383	16	63	62,502,048 <sup>1</sup>

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

### 4.1 Performance Specification

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

**Table 4-2:** Performance specifications

Capacity \ Performance	1GB / 2GB / 4GB	8 GB	16GB / 32 GB
	<b>Sustained read (MB/s)</b>	25	35
<b>Sustained write (MB/s)</b>	7	10	15

<sup>1</sup>. Above figures measured based on flash configurations.

### 4.2 Environmental Specification

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

**Table 4-3:** Environmental specifications

Environment		Specification
Temperature	Operation	0°C to 70°C; -40°C to 85°C (ET <sup>1</sup> )
	Storage	-40°C to 100°C
Humidity		5% to 95% RH (Non-condensing)
Vibration (Non-Operation)		Sine wave: 10~2000Hz, 15G (X, Y, Z axes)
Shock (Non-Operation)		Half sine wave, Peak acceleration 50 G, 11 ms (X, Y, Z ; All 6 axes)

<sup>1</sup>. Extended Temperature

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## **5. Flash Management**

### **5.1 Intelligent Endurance Design**

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#### **5.1.1 Advanced wear-leveling algorithms**

The NAND flash devices are limited by a certain number of write cycles. When using a file system, frequent file table updates is mandatory. If some area on the flash wears out faster than others, it would significantly reduce the lifetime of the whole device, 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. The scheme is achieved both via buffer management and Apacer-specific advanced wear leveling to ensure that the lifetime of the flash media can be increased, and the disk access performance is optimized as well.

#### **5.1.2 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.

#### **5.1.3 Built-in hardware ECC**

The ATA-Flash Drive 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.

#### **5.1.4 Enhanced data integrity**

The properties of NAND flash memory make it ideal for applications that require high integrity while operating in challenging environments. The integrity of data to NAND flash memory is generally maintained through ECC algorithms and bad block management. Flash controllers can support up to 8 bits ECC capability for accuracy of data transactions, and bad block management is a preventive mechanism from loss of data by retiring unusable media blocks and relocating the data to the other blocks, along with the integration of advanced wear leveling algorithms, so that the lifespan of device can be expanded.



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## **5.2 Intelligent Power Failure Recovery**

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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.

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## **5.3 Enhanced Security Level**

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### **5.3.1 Secure protection zone**

Partitioning with static commands to logically secure data, protection zones are the solid frameworks of file vaults. 3 different types of zones, unprotected, read-only, and restricted, are offered for effortless administration. When the product is shipped out of Apacer, all sectors are in the unprotected zone, which means there is no control on any data transaction. For further management control, the read-only zone can be set to be accessed exclusively for grantees, and the restricted zone, to be as the maximum security stockade with full administration privilege required. A maximum of 4 zones can be configured as either restricted or read-only zone presenting concurrently. The space outside these 4 zones is automatically in the unprotected zone if available. After the zone has been configured, the protection zone can be de-activated or re-activated by either software methods or hardware components. Protection zone configuration is non-volatile and it will be in effect until the next set of configuration overwrites it.

### **5.3.2 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.

## 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	FR <sup>1</sup>	SC <sup>2</sup>	SN <sup>3</sup>	CY <sup>4</sup>	DH <sup>5</sup>	LBA <sup>6</sup>
Check-Power-Mode	E5H or 98H	-	-	-	-	D <sup>8</sup>	-
Execute-Drive-Diagnostic	90H	-	-	-	-	D	-
Erase Sector(s)	C0H	-	Y	Y	Y	Y	Y
Flush-Cache	E7H	-	-	-	-	D	-
Format Track	50H	-	Y <sup>7</sup>	-	Y	Y <sup>8</sup>	Y
Identify-Drive	ECH	-	-	-	-	D	-
Idle	E3H or 97H	-	Y	-	-	D	-
Idle-Immediate	E1H or 95H	-	-	-	-	D	-
Initialize-Drive-Parameters	91H	-	Y	-	-	Y	-
NOP	00H	-	-	-	-	D	-
Read-Buffer	E4H	-	-	-	-	D	-
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	1XH	-	-	-	-	D	-
Request-Sense	03H	-	-	-	-	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	Y	Y
Set-Features	EFH	Y <sup>7</sup>	-	-	-	D	-

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

Command	Code	FR <sup>1</sup>	SC <sup>2</sup>	SN <sup>3</sup>	CY <sup>4</sup>	DH <sup>5</sup>	LBA <sup>6</sup>
SMART	B0H	Y	Y	Y	Y	D	
Set-Multiple-Mode	C6H	-	Y	-	-	D	-
Set-Sleep-Mode	E6H or 99H	-	-	-	-	D	-
Standby	E2H or 96H	-	-	-	-	D	-
Standby-Immediate	E0H or 94H	-	-	-	-	D	-
Translate-Sector	87H	-	Y	Y	Y	Y	Y
Write-Buffer	E8H	-	-	-	-	D	-
Write-DMA	CAH or CBH	-	Y	Y	Y	Y	Y
Write-Multiple	C5H	-	Y	Y	Y	Y	Y
Write-Multiple-Without-Erase	CDH	-	Y	Y	Y	Y	Y
Write-Sector(s)	30H or 31H	-	Y	Y	Y	Y	Y
Write-Sector-Without-Erase	38H	-	Y	Y	Y	Y	Y
Write-Verify	3CH	-	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 ATA-Flash Drive and Head parameters are used  
 D means only the ATA-Flash Drive parameter is valid and not the Head parameter

## 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 voltage

Range	Ambient Temperature	3.3V
Standard	0°C to 70°C	3.135-3.465V
Extended Temperature	-40°C to 85°C	

**Table 7-2:** Absolute maximum power pin stress ratings

Parameter	Symbol	Conditions
Input Power	V <sub>DD</sub>	-0.3V min. to 6.5V max.
Voltage on any pin except V <sub>DD</sub> with respect to GND	V	-0.5V min. to V <sub>DD</sub> + 0.5V max.

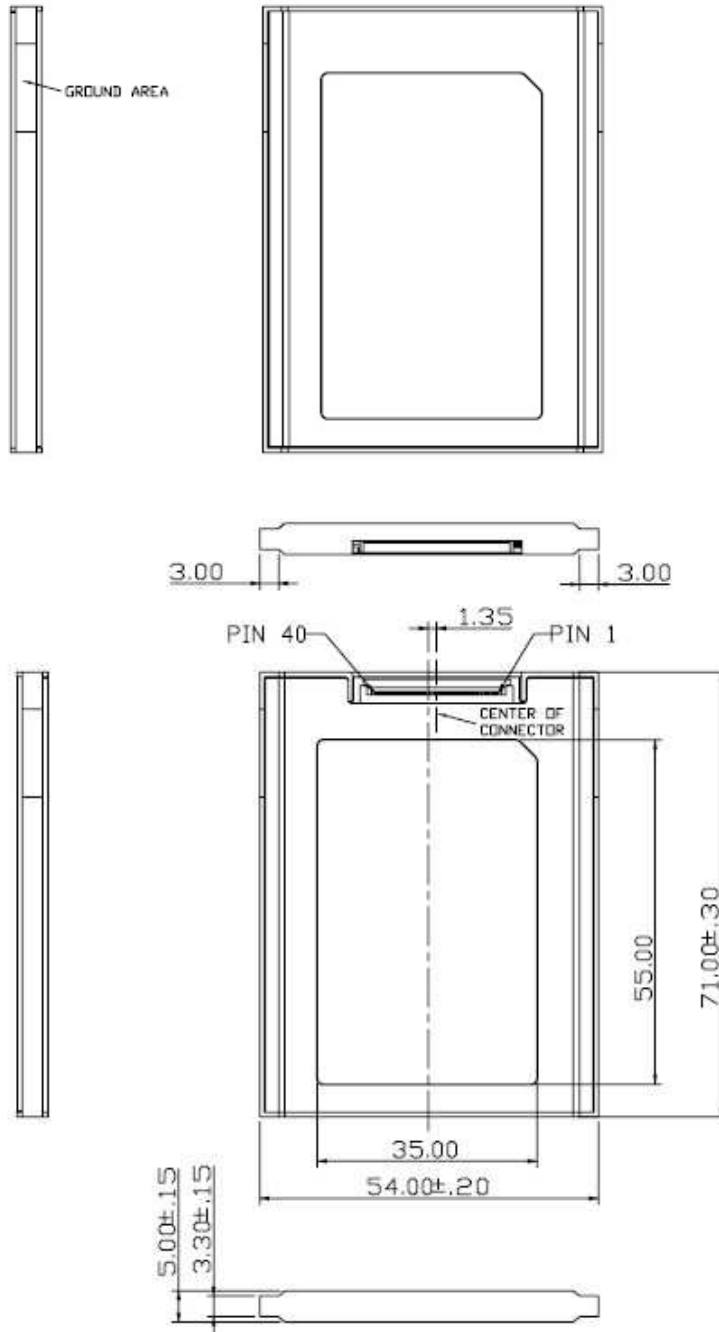
**Table 7-3:** Recommended system power-up timings

Symbol	Parameter	Typical	Maximum	Units
T <sub>PU-READY</sub> <sup>1</sup>	Power-up to Ready Operation	200	1000	ms
T <sub>PU-WRITE</sub> <sup>1</sup>	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

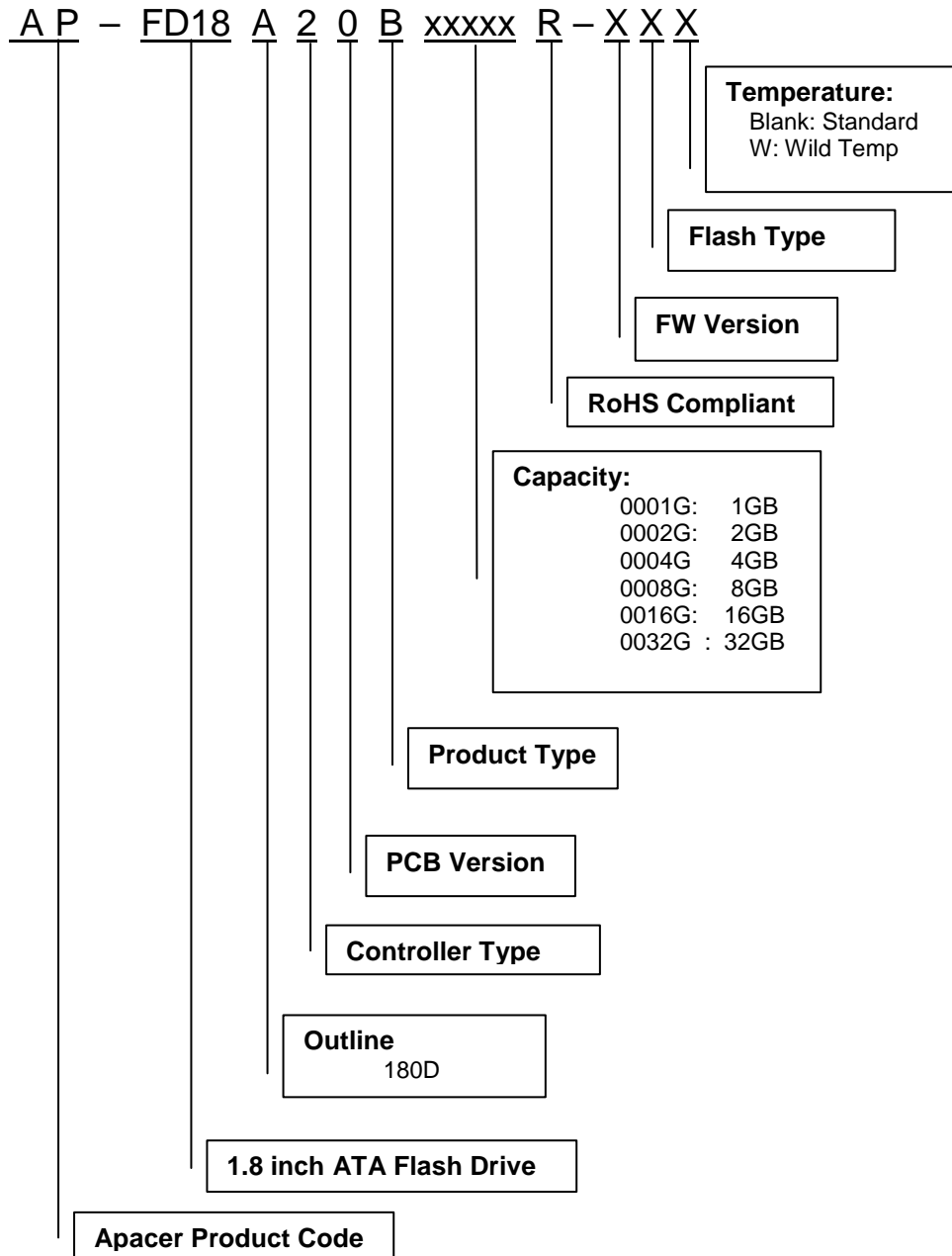
### 8.1 Dimension



Unit: mm

## 9. Product Ordering Information

### 9.1 Product Code Designation



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## 9.2 Valid Combinations

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<b>Capacity</b>	<b>Model Number</b>
1GB	AP-FD18A20B0001GR-KS
2GB	AP-FD18A20B0002GR-KS
4GB	AP-FD18A20B0004GR-KS
8GB	AP-FD18A20B0008GR-KS
16GB	AP-FD18A20B0016GR-KS
32GB	AP-FD18A20B0032GR-KT

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## Revision History

<b>Revision</b>	<b>Date</b>	<b>Description</b>	<b>Remark</b>
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	



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## Global Presence

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