*RoHS Compliant*

# ATA Flash Drive 257

## *Product Specifications*

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***Version 1.7***

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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-6
- **Capacity**
  - 4, 8, 16, 32, 64, 128 GB
- **Performance***
  - Sustained read: Up to 100 MB/sec
  - Sustained write: Up to 95 MB/sec
- **Flash Management**
  - Advanced wear-leveling algorithms
  - S.M.A.R.T.
  - Built-in Hardware ECC: 72bit/1KB
  - Flash Block Management
  - ATA Secure Erase
  - Power Failure Management
- **NAND Flash Type:** SLC
- **Temperature Range**
  - Operating:
    Standard: 0°C to 70°C
    Extended: -40°C to 85°C
  - Storage: -40°C to 100°C
- **Power Consumption***
  - Supply voltage: 5V
  - Active mode: 295 mA
  - Idle mode: 35 mA
- **Connector Type**
  - 44-pin male
- **Master/Slave Jumper Setting**
- **RoHS Compliant**

*Varies from capacities. The values presented in Performance and Power consumption are typical and may vary depending on various settings and platforms.


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# Table of Contents

1. GENERAL DESCRIPTION ..... 3

2. FUNCTIONAL BLOCK ..... 3

3. PIN ASSIGNMENTS ..... 4

3.1 PIN DEFINITIONS ..... 4
3.2 JUMPER SETTING ..... 5

4. PRODUCT SPECIFICATIONS ..... 6

4.1 CAPACITY ..... 6
4.2 PERFORMANCE SPECIFICATIONS ..... 6
4.3 ENVIRONMENTAL SPECIFICATIONS ..... 6

5. FLASH MANAGEMENT ..... 7

5.1 ADVANCED WEAR-LEVELING ALGORITHMS ..... 7
5.2 S.M.A.R.T. ..... 7
5.3 BUILT-IN HARDWARE ECC ..... 7
5.4 FLASH BLOCK MANAGEMENT ..... 7
5.5 POWER FAILURE MANAGEMENT ..... 8

6. SOFTWARE INTERFACE ..... 9

6.1 COMMAND SET ..... 9
6.2 ATA SECURE ERASE ..... 9

7. ELECTRICAL SPECIFICATIONS ..... 10

8. PHYSICAL CHARACTERISTICS ..... 11

9. PRODUCT ORDERING INFORMATION ..... 12

9.1 PRODUCT CODE DESIGNATIONS ..... 12
9.2 VALID COMBINATIONS ..... 13



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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 standard 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, 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.

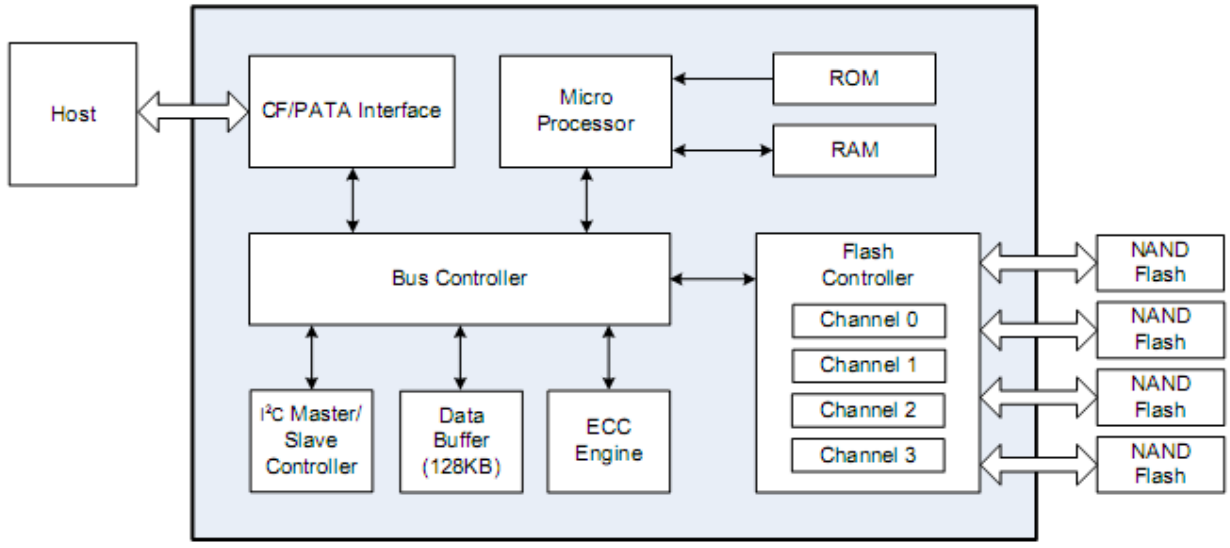



**Figure 2-1** ATA-Flash Drive Functional Block Diagram


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# 3. Pin Assignments

## 3.1 Pin Definitions

Table 3-1 lists the pin assignments with respective signal names for the 44-pin configuration. A "#" suffix indicates the active low signal. The pin type can be input, output or input/output.

**Figure 3-1** ATA-Flash Drive 44-Pin Connector

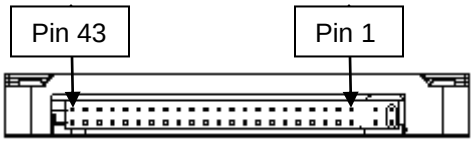
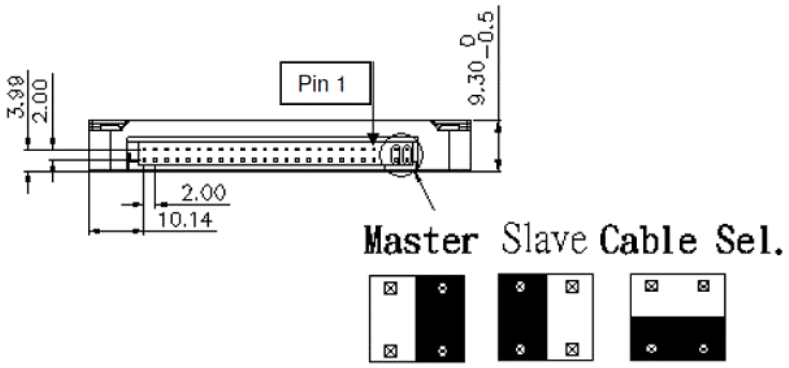



**Table 3-1** Pin Assignments for the 44-Pin Configuration

| Pin No. | Signal Name | Pin Type | Pin No. | Signal Name | Pin Type |
|---|---|---|---|---|---|
| **1** | RESET# | I | **2** | GND | - |
| **3** | D7 | I/O | **4** | D8 | I/O |
| **5** | D6 | I/O | **6** | D9 | I/O |
| **7** | D5 | I/O | **8** | D10 | I/O |
| **9** | D4 | I/O | **10** | D11 | I/O |
| **11** | D3 | I/O | **12** | D12 | I/O |
| **13** | D2 | I/O | **14** | D13 | I/O |
| **15** | D1 | I/O | **16** | D14 | I/O |
| **17** | D0 | I/O | **18** | D15 | I/O |
| **19** | GND | - | **20** | NC | - |
| **21** | DMARQ | O | **22** | GND | |
| **23** | IOWR# | I | **24** | GND | - |
| **25** | IORD#<br>HDMARDY#<br>HSTROBE# | I | **26** | GND | - |
| **27** | IORDY<br>DDMARDY#<br>DSTROBE | O | **28** | CSEL | I |
| **29** | DMACK# | I | **30** | GND | - |
| **31** | INTRQ | O | **32** | IOCS16# | O |
| **33** | A1 | I | **34** | PDIAG# | I/O |
| **35** | A0 | I | **36** | A2 | I |
| **37** | CS1FX# | I | **38** | CS3FX# | I |
| **39** | DASP# | I/O | **40** | GND | - |
| **41** | VDD | - | **42** | VDD | - |
| **43** | GND | - | **44** | NC | - |


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## 3.2 Jumper Setting





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# 4. Product Specifications

## 4.1 Capacity

Capacity specifications of the ATA-Flash Drive (AFD) list out unformatted, out-of-box capacity information.

**Table 4-1** Capacity Specifications

| Capacity | Total bytes* | Cylinders** | Heads | Sectors | Max LBA |
|---|---|---|---|---|---|
| 4 GB | 4,011,614,208 | 7,773 | 16 | 63 | 7,835,184 |
| 8 GB | 8,012,390,400 | 15,525 | 16 | 63 | 15,649,200 |
| 16 GB | 16,013,942,784 | 16,383 | 16 | 63 | 31,277,232 |
| 32 GB | 32,017,047,552 | 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 |

*Display of total bytes varies from file systems.
**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.

## 4.2 Performance Specifications

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

**Table 4-2** Performance Specifications

| Performance \ Capacity | 4 GB | 8 GB | 16 GB | 32 GB | 64 GB | 128 GB |
|---|---|---|---|---|---|---|
| **Sustained Read (MB/s)** | 100 | 100 | 100 | 100 | 100 | 100 |
| **Sustained Write (MB/s)** | 95 | 85 | 90 | 95 | 95 | 95 |

Note: Performance varies from flash or host system configurations.

## 4.3 Environmental Specifications

Environmental specifications of the ATA-Flash Drive follow the standards of MIL-STD-810F.

**Table 4-3** Environmental Specifications

| Item | Criteria |
|---|---|
| **Non-Operating Temperature** | -40°C to 100°C |
| **Operating Temperature** | 0°C to 70°C (Standard); -40°C to 85°C (Extended) |
| **Non-Operating Vibration** | Sine wave: 15(G), 10~2000(Hz); X, Y, Z axis |
| **Non-Operating Shock** | 1500(G), 0.5(ms), ±X, ±Y, ±Z axis |


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# 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. On the other hand, NAND flash storage adopt flash as their primary media. 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 earlier. 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.

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 attributes 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 specifications. Based on the SFF-8035i Rev. 2.0 specifications, SMART 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 SMART Utility running on the host, it analyzes and reports the disk status to the host before the device reaches in critical condition.

## 5.3 Built-in Hardware ECC

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. This ATA-Flash Drive is programmed with a hardware ECC engine which correct up to 72 bits per 1KB.

## 5.4 Flash Block Management

Current process technology is unable to guarantee total reliability of NAND flash memory array. When a flash memory device leaves factory, it comes with a highly minimal number of initial bad block during production or out-of-factory as there is no currently known technology that produce flash chips free of bad blocks. On the other hand, 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.


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## 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.


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# 6. Software Interface

## 6.1 Command Set

**Table 6-1** Command Set

| Code | Command | Code | Command |
|---|---|---|---|
| E5h | Check Power Mode | F6h | Security Disable Password |
| 92h | Download Microcode | F3h | Security Erase Prepare |
| 90h | Execute Device Diagnostic | F4h | Security Erase Unit |
| E7h | Flush Cache | F5h | Security Freeze Lock |
| EAh | Flush Cache EXT | F1h | Security Set Password |
| ECh | Identify Device | F2h | Security Unlock |
| A1h | Identify Packet Device | 70h | Seek |
| E3h | Idle | EFh | Set Features |
| E1h | Idle Immediate | F9h | Set Max* |
| 91h | Initialize Device Parameters | 37h | Set Max Address EXT |
| 00h | NOP | C6h | Set Multiple Mode |
| E4h | Read Buffer | E6h | Sleep |
| C8h | Read DMA | B0h | SMART |
| 25h | Read DMA EXT | E2h | Standby |
| C4h | Read Multiple | E0h | Standby Immediate |
| 29h | Read Multiple EXT | E8h | Write Buffer |
| F8h | Read Native Max Address | CAh | Write DMA |
| 27h | Read Native Max Address EXT | 35h | Write DMA EXT |
| 20h | Read Sector | C5h | Write Multiple |
| 24h | Read Sector EXT | 39h | Write Multiple EXT |
| 40h | Read Verify Sectors | 30h | Write Sector |
| 42h | Read Verify Sectors EXT | 34h | Write Sector EXT |
| 10h | Recalibrate | | |

*The command can be configured as “Set Max Lock”, “Set Max Address”, “Set Max Set Password”, “Set Max Unlock” and “Set Max Freeze Lock”, depending on the transfer mode in operation.

## 6.2 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.


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# 7. Electrical Specifications

**Table 7-1** Operating Voltage & Temperature

| | | |
|---|---|---|
| **Ambient Temperature** | **Standard** | 0°C to 70°C |
| | **Extended** | -40°C to 85°C |
| **Operating Voltage** | | 5V± 5% (4.75-5.25V) |

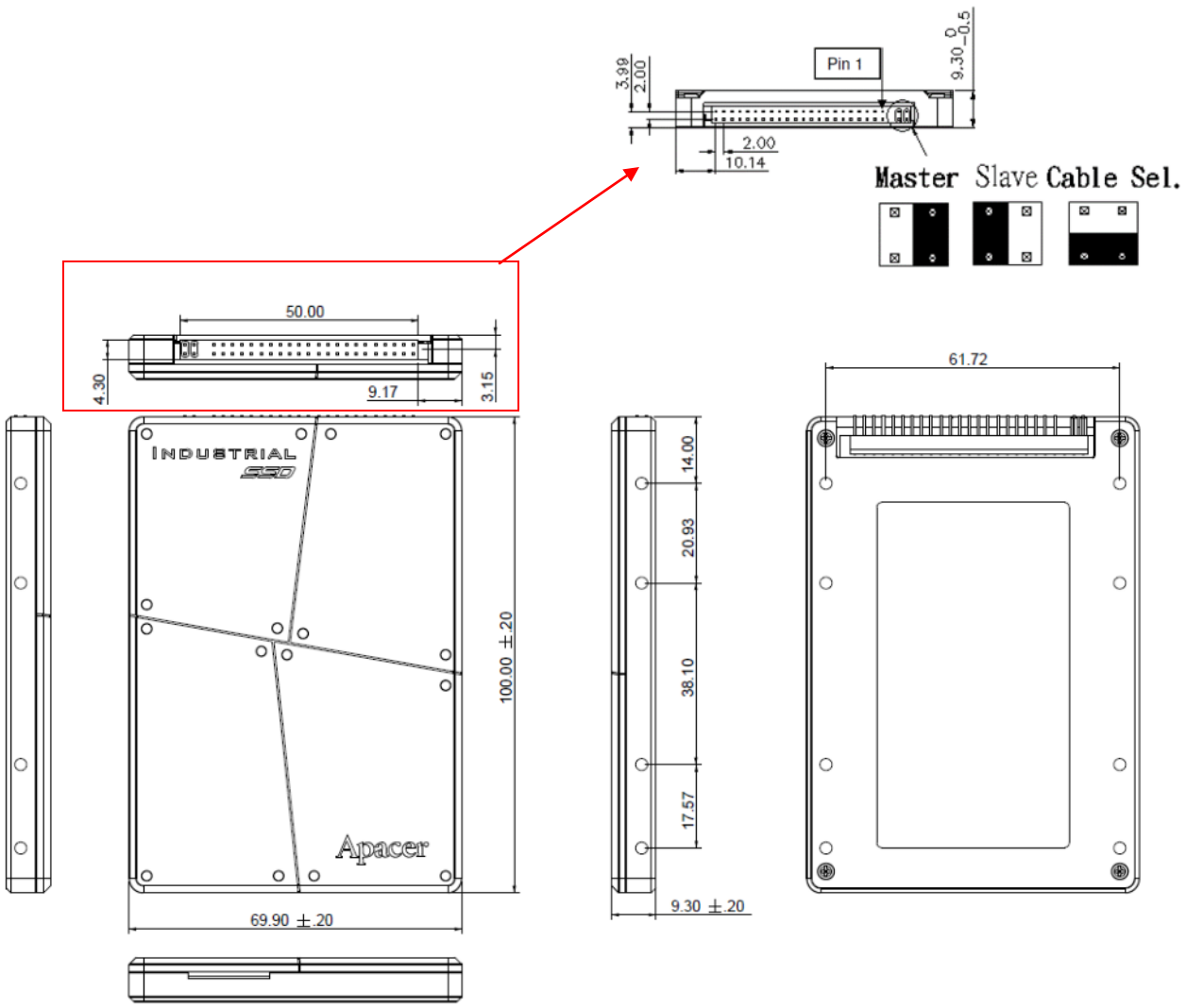
**Table 7-2** Power Consumption

| Capacity / Mode | 4 GB | 8 GB | 16 GB | 32 GB | 64 GB | 128 GB |
|---|---|---|---|---|---|---|
| **Active (mA)** | 255 | 220 | 240 | 265 | 290 | 295 |
| **Idle (mA)** | 15 | 30 | 30 | 30 | 35 | 35 |

Note: Power consumption varies from flash or host system configurations.


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# 8. Physical Characteristics



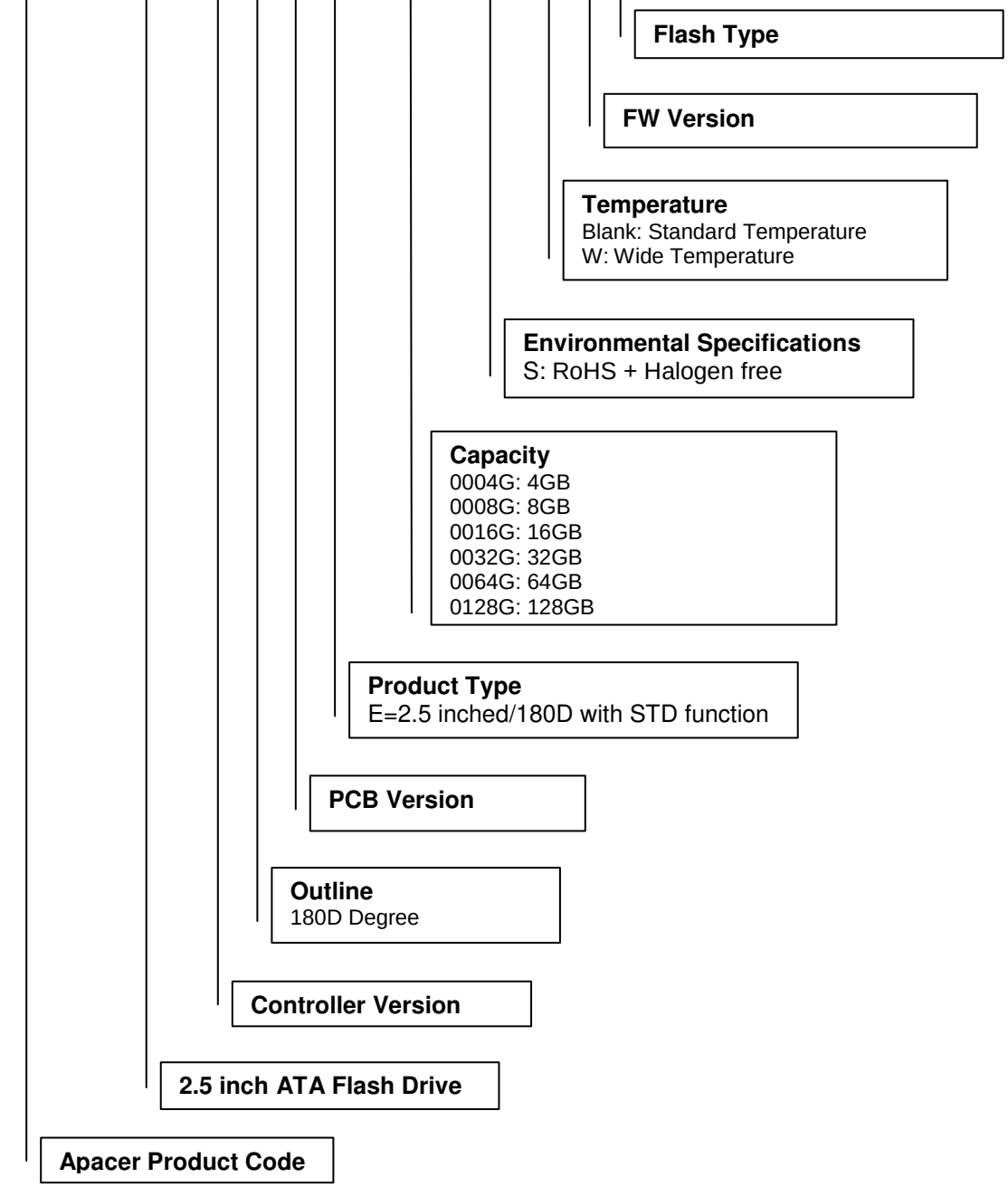

Unit: mm
Tolerance: ± 0.2


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# 9. Product Ordering Information

## 9.1 Product Code Designations

AP – FD25 C 2 3 E xxxxG S – X X X





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## 9.2 Valid Combinations

### 9.2.1 Standard Temperature

| Capacity | Model Number |
|---|---|
| 4GB | AP-FD25C23E0004GS-3T |
| 8GB | AP-FD25C23E0008GS-3T |
| 16GB | AP-FD25C23E0016GS-3T |
| 32GB | AP-FD25C23E0032GS-3T |
| 64GB | AP-FD25C23E0064GS-3T |
| 128GB | AP-FD25C23E0128GS-3T |

### 9.2.2 Wide Temperature

| Capacity | Model Number |
|---|---|
| 4GB | AP-FD25C23E0004GS-W3T |
| 8GB | AP-FD25C23E0008GS-W3T |
| 16GB | AP-FD25C23E0016GS-W3T |
| 32GB | AP-FD25C23E0032GS-W3T |
| 64GB | AP-FD25C23E0064GS-W3T |
| 128GB | AP-FD25C23E0128GS-W3T |

**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.


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# Revision History

| Revision | Date | Description | Remark |
|---|---|---|---|
| 0.1 | 07/10/2012 | Preliminary release | |
| 1.0 | 08/03/2012 | Official release | |
| 1.1 | 10/08/2013 | Added jumper setting drawing | |
| 1.2 | 03/27/2015 | Revised Product Ordering Information due to flash change | |
| 1.3 | 09/07/2015 | Revised power consumption for all models | |
| 1.4 | 06/20/2016 | Revised the code for the Set Max Address EXT command | |
| 1.5 | 12/2/2016 | Updated product ordering information | |
| 1.6 | 2/17/2017 | Added 4GB support | |
| 1.7 | 3/8/2017 | Updated 4GB performance and power consumption values | |


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