

**RoHS Compliant**

**Value Added ATA Disk Module III**  
**Specification for Mini ADM (44P/90D)**

**March 26, 2009**

**Revision 1.4**



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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**
  - 44-pin female connector
- **Low power consumption (typical)**
  - Supply voltage: 3.3V & 5V
  - Active mode: 85mA/95mA (3.3V/5V)
  - Sleep mode: 500µA /600µA (3.3V/5V)
- **Performance**
  - Sustained read: Up to 35 MB/sec
  - Sustained write:
    - Standard: Up to 15 MB/sec
    - High Speed: Up to 25 MB/sec
- **Capacity**
  - Standard:
    - 128, 256, 512 MB
    - 1, 2, 16 GB
  - High Speed:
    - 256, 512 MB
    - 1, 2, 4, 8 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*
    - Quick erase*
- **RoHS compliant**

1. Extended Temperature

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## **Table of Contents**

|   |           |
|---|-----------|
| <b>1. GENERAL DESCRIPTION</b> .....           | <b>4</b>  |
| 1.1 PERFORMANCE-OPTIMIZED CONTROLLER .....    | 4         |
| 1.1.1 Power Management Unit (PMU).....        | 4         |
| 1.1.2 SRAM Buffer.....                        | 4         |
| <b>2. FUNCTIONAL BLOCK</b> .....              | <b>5</b>  |
| <b>3. PIN ASSIGNMENTS</b> .....               | <b>6</b>  |
| <b>4. CAPACITY SPECIFICATION</b> .....        | <b>7</b>  |
| 4.1 PERFORMANCE SPECIFICATION.....            | 7         |
| 4.2 ENVIRONMENTAL SPECIFICATION.....          | 8         |
| <b>6. SOFTWARE INTERFACE</b> .....            | <b>11</b> |
| 6.1 COMMAND SET .....                         | 11        |
| <b>5. FLASH MANAGEMENT</b> .....              | <b>9</b>  |
| 5.1 INTELLIGENT ENDURANCE DESIGN.....         | 9         |
| 5.1.1 Advanced wear-leveling algorithms ..... | 9         |
| 5.1.2 S.M.A.R.T. technology .....             | 9         |
| 5.1.3 Built-in hardware ECC.....              | 9         |
| 5.1.4 Enhanced data integrity.....            | 9         |
| 5.2 INTELLIGENT POWER FAILURE RECOVERY.....   | 10        |
| 5.3 ENHANCED SECURITY LEVEL .....             | 10        |
| 5.3.1 Secure protection zone.....             | 10        |
| 5.3.2 Quick erase.....                        | 10        |
| <b>7. ELECTRICAL SPECIFICATION</b> .....      | <b>13</b> |
| <b>8. PHYSICAL CHARACTERISTICS</b> .....      | <b>14</b> |
| 8.1 DIMENSION – MINI ADM .....                | 14        |
| 8.1.1 44 pin/ 90 degree .....                 | 14        |
| <b>9. PRODUCT ORDERING INFORMATION</b> .....  | <b>16</b> |
| 9.1 PRODUCT CODE DESIGNATIONS .....           | 16        |
| 9.2 VALID COMBINATIONS .....                  | 17        |

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## 1. General Description

Apacer's ATA-Disk Module (ADM) is a high-performance, embedded flash drive designed to replace the conventional IDE hard disk drive. The ADMs can be plugged into a standard IDE connector commonly found in desktops, IT-STB, industrial PCs and thin client systems. Apacer's ADM SSD has a built-in microcontroller with file management firmware that communicates with the ATA standard interfaces. No additional or proprietary host software is required.

Well suited for embedded flash storage applications by offering new and expanded functionalities as well as more cost-effective designs, better performance and increased reliability, ADM is designed to work at either 5 or 3.3 Volts, supports the standard ATA/IDE protocol for up to PIO Mode-4, Multiword DMA Mode-2 and Ultra DMA Mode-4 interfaces, and uses the standard ATA driver complying with 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, Enhanced Data Integrity, Intelligent Power Failure Recovery, Secure Protection Zone and Quick Erase, Apacer's ADM assures users of a versatile device on data storage.

### 1.1 Performance-Optimized Controller

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The kernel of an ATA-Disk Module is the ATA controller, which translates standard ATA signals into the 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)

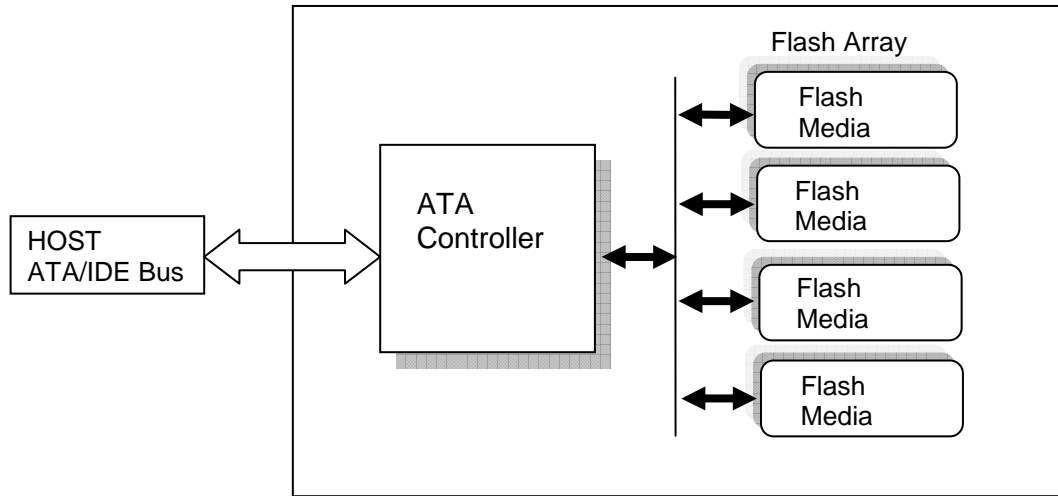
The power management unit (PMU) controls the power consumption of the ATA-Disk Module. It reduces the power consumption of the ATA-Disk Module Controller by putting circuitry not in operation into sleep mode. The PMU has zero wake-up latency.

#### 1.1.2 SRAM Buffer

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

## 2. Functional Block

The ATA-Disk Module (ADM) 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 44-pin configuration. A “#” suffix indicates the active low signal. The pin type can be input, output or input/output.

**Table 3-1:** Pin assignments for the 44-pin configuration

| Pin No. | Signal Name                   | Pin Type | I/O Type <sup>1</sup> | Pin No. | Signal Name         | Pin Type | I/O Type |
|---------|-------------------------------|----------|-----------------------|---------|---------------------|----------|----------|
| 1       | RESET#                        | I        | I2U                   | 2       | GND                 | -        | Ground   |
| 3       | D7                            | I/O      | I1Z, O2               | 4       | D8                  | I/O      | I1Z, O2  |
| 5       | D6                            | I/O      | I1Z, O2               | 6       | D9                  | I/O      | I1Z, O2  |
| 7       | D5                            | I/O      | I1Z, O2               | 8       | D10                 | I/O      | I1Z, O2  |
| 9       | D4                            | I/O      | I1Z, O2               | 10      | D11                 | I/O      | I1Z, O2  |
| 11      | D3                            | I/O      | I1Z, O2               | 12      | D12                 | I/O      | I1Z, O2  |
| 13      | D2                            | I/O      | I1Z, O2               | 14      | D13                 | I/O      | I1Z, O2  |
| 15      | D1                            | I/O      | I1Z, O2               | 16      | D14                 | I/O      | I1Z, O2  |
| 17      | D0                            | I/O      | I1Z, O2               | 18      | D15                 | I/O      | I1Z, O2  |
| 19      | GND                           | -        | Ground                | 20      | NC                  | -        | -        |
| 21      | DMARQ#                        | O        | O1                    | 22      | GND                 |          | Ground   |
| 23      | IOWR#<br>STOP                 | I        | I2Z                   | 24      | GND                 | -        | Ground   |
| 25      | IORD#<br>HDMARDY#<br>HSTROBE# | I        | I2Z                   | 26      | GND                 | -        | Ground   |
| 27      | IORDY<br>DDMARDY#<br>DSTROBE  | O        | O1                    | 28      | NC/CSEL             | I        | I1U      |
| 29      | DMACK#                        | I        | I2U                   | 30      | NC/WP# <sup>1</sup> | -/I      | -/I1U    |
| 31      | INTRQ                         | O        | O1                    | 32      | IOCS16#             | O        | O2       |
| 33      | A1                            | I        | I1Z                   | 34      | PDIAG#              | I/O      | I1U, O1  |
| 35      | A0                            | I        | I1Z                   | 36      | A2                  | I        | I1Z      |
| 37      | CS1FX#                        | I        | I2Z                   | 38      | CS3FX#              | I        | I2Z      |
| 39      | DASP#                         | I/O      | I1U, O6               | 40      | GND                 | -        | Ground   |
| 41      | VDD                           | -        | Power                 | 42      | VDD                 | -        | Power    |
| 43      | GND                           | -        | Ground                | 44      | NC                  | -        | -        |

1. Pin 30 is selectable as NC or WP# through a zero ohm resistor jumper. Default is NC. Note that pin 30 is a GND pin on standard ATA interface. This pin could be redesigned for host to control the write protect function on ADM

## 4. Capacity Specification

Capacity specification of the ATA-Disk Module (ADM) product family is available as shown in Table 4-1. It lists the specific capacity and the default numbers of heads, sectors and cylinders for each product line.

**Table 4-1:** Capacity specifications

| Capacity | Total bytes    | Cylinders          | Heads | Sectors | Max LBA    |
|----------|----------------|--------------------|-------|---------|------------|
| 128 MB   | 128,057,344    | 977                | 8     | 32      | 250,112    |
| 256 MB   | 256,901,120    | 980                | 16    | 32      | 501,760    |
| 512 MB   | 512,483,328    | 993                | 16    | 63      | 1,000,944  |
| 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 |
| 16GB     | 16,001,040,384 | 16383 <sup>1</sup> | 16    | 63      | 31,252,032 |

1. CYLINDERS, HEADS OR SECTORS ARE NOT APPLICABLE FOR THESE CAPACITIES. ONLY LBA ADDRESSING APPLIES

### 4.1 Performance Specification

Performances of the ATA-Disk Module are listed in Table 4-2 and Table 4-3.

**Table 4-2:** Standard Performance specifications

| Performance \ Capacity | 128 MB / 256 MB | 2 GB | 16 GB |
|------------------------|-----------------|------|-------|
|                        | 512 MB / 1 GB   |      |       |
| Sustained read (MB/s)  | 19              | 35   | 22    |
| Sustained write (MB/s) | 7               | 15   | 15    |

**Table 4-3:** High Speed Performance specifications

| Performance \ Capacity | 256 MB / 512 MB       | 1GB / 2 GB / 4 GB / 8 GB |
|------------------------|-----------------------|--------------------------|
|                        | Sustained read (MB/s) | 30                       |
| Sustained write (MB/s) | 13                    | 25                       |

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## 4.2 Environmental Specification

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Environmental specification of the ATA-Disk Module (ADM) product family follows the MIL-STD-810F standard which is shown in Table 4-4.

**Table 4-4:** 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) |

1. 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-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.

#### **5.1.4 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.

## **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 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.

## 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-Disk Module (ADM). Commands are issued to the ADM 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-Disk Module and Head parameters are used  
D means only the ATA-Disk Module 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 range**

| Range                | Ambient Temperature | 3.3V         | 5V         |
|----------------------|---------------------|--------------|------------|
| Standard             | 0°C to +70°C        | 3.135-3.465V | 4.75-5.25V |
| 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 timing**

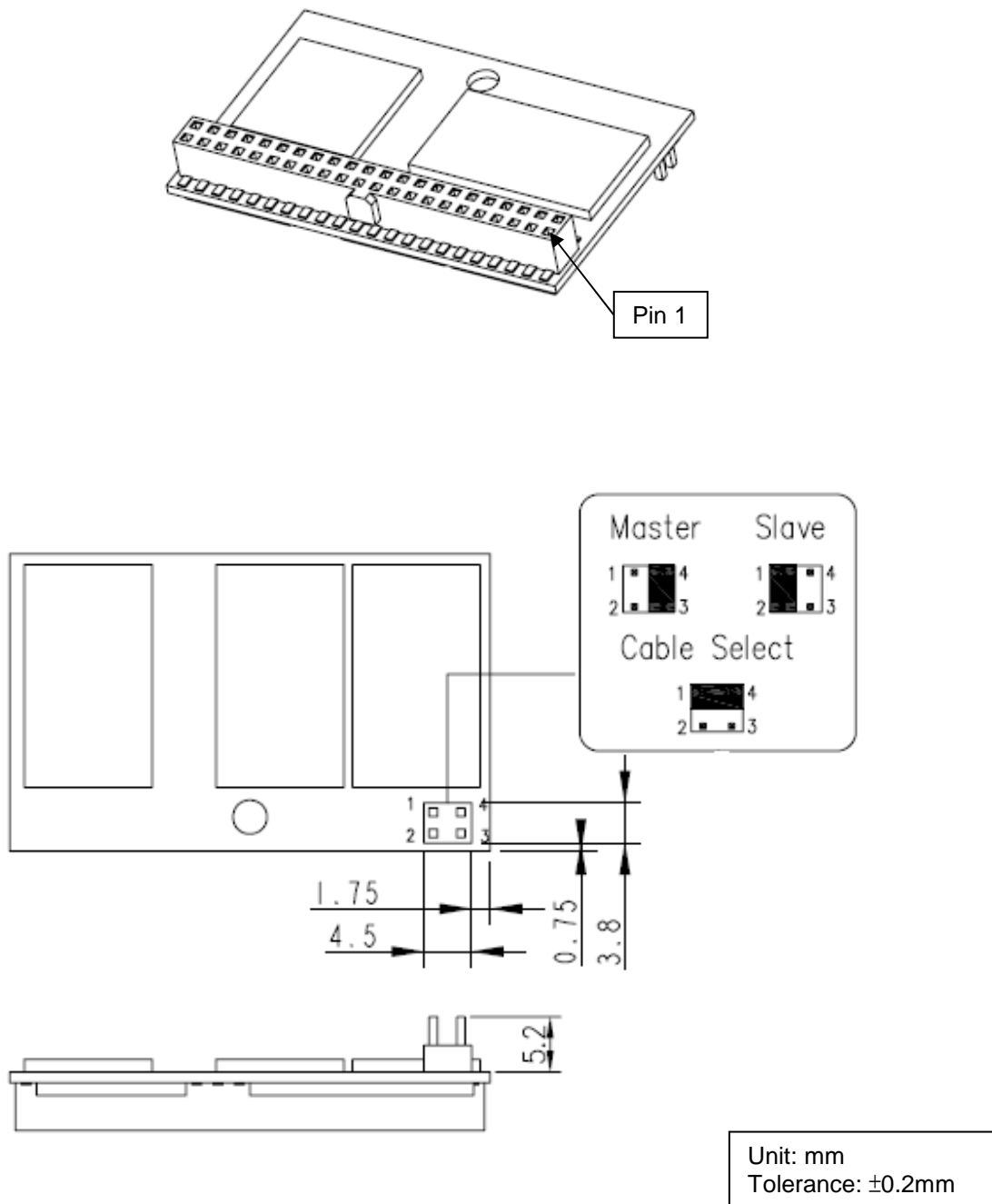
| Symbol                             | Parameter                   | Typical | Maximum | Units |
|------------------------------------|-----------------------------|---------|---------|-------|
| T <sub>PU-READY</sub> <sup>1</sup> | Power-up to Ready Operation | 200     | 1000    | ms    |
| T <sub>PU-WRITE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

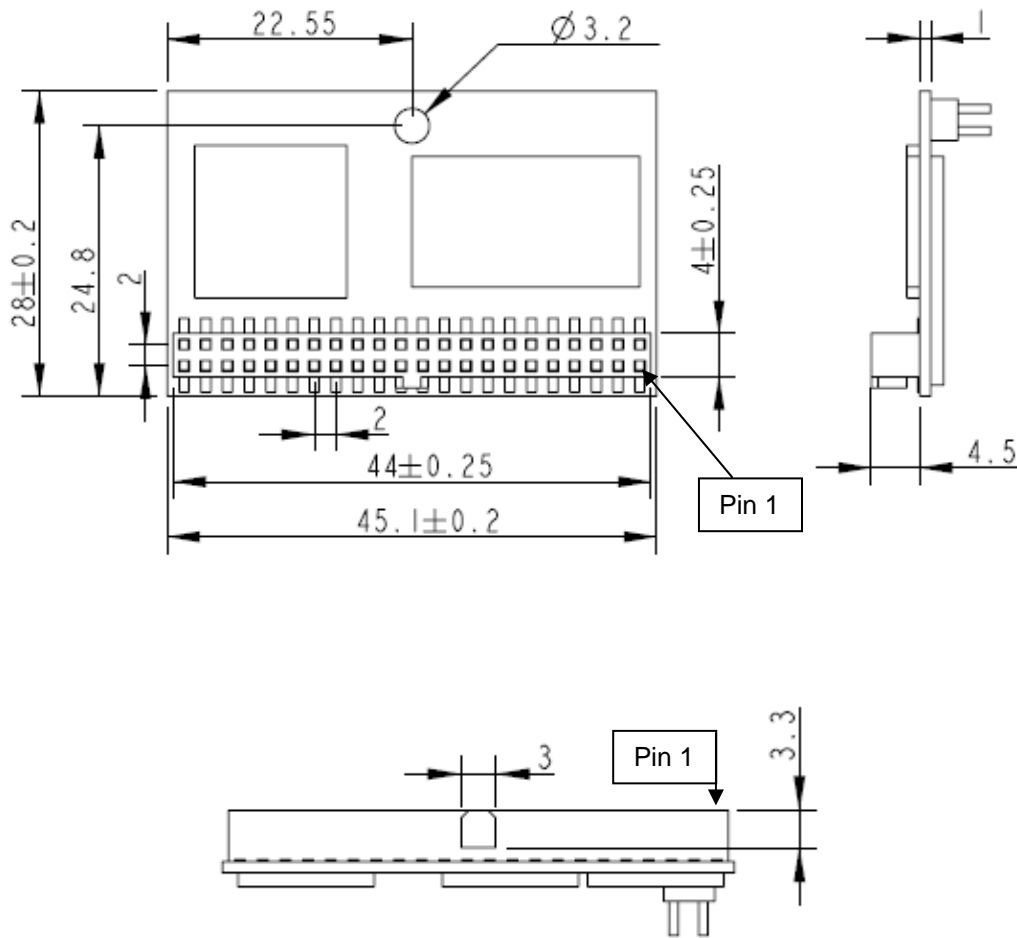
## 8. Physical Characteristics

### 8.1 Dimension – Mini ADM

#### 8.1.1 44 pin/ 90 degree



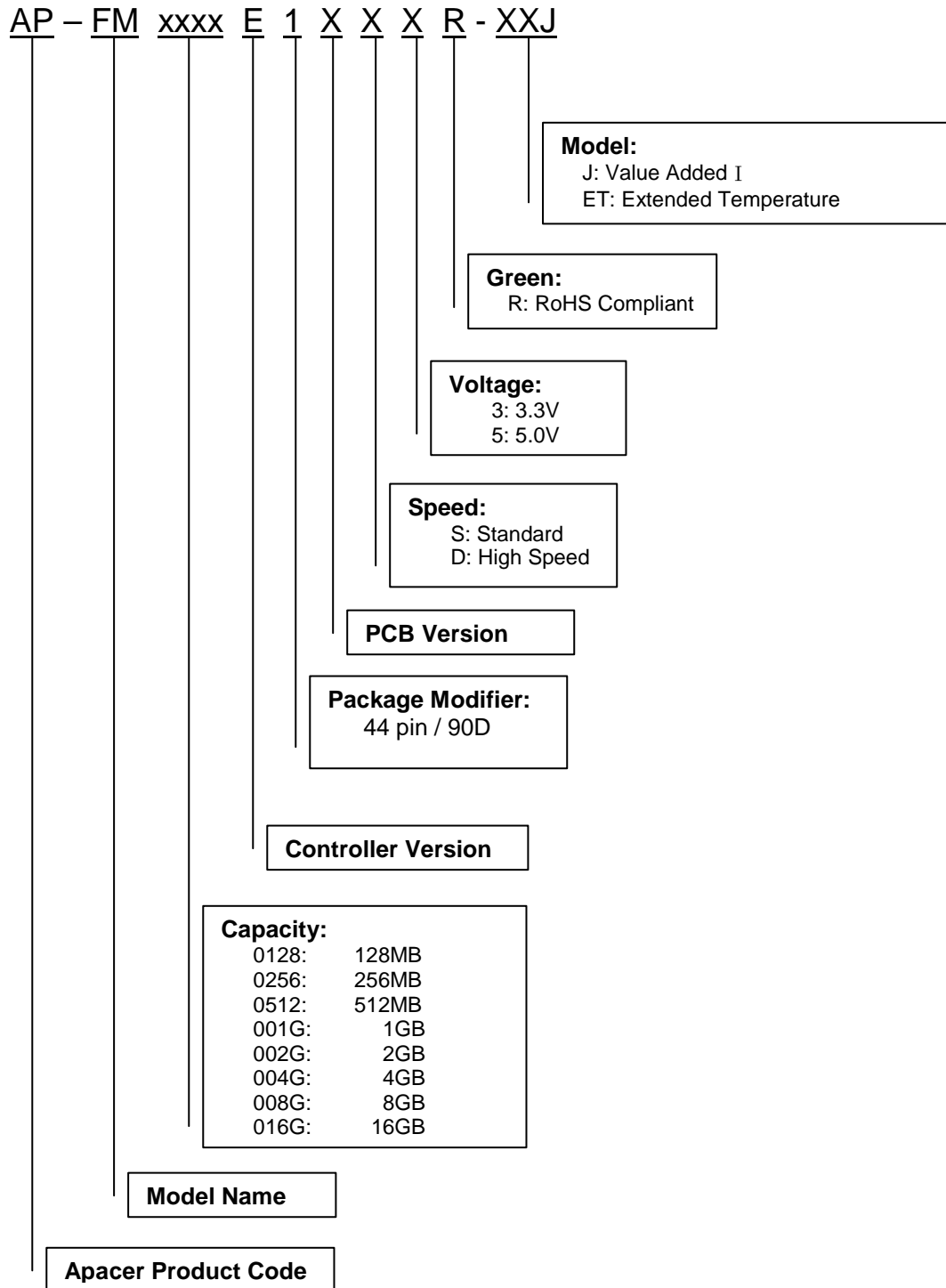
**Value Added ATA-Disk Module III**  
**AP-FMxxxxE1XXXR-XXJ**



Unit: mm  
Tolerance:  $\pm 0.2$ mm

## 9. Product Ordering Information

### 9.1 Product Code Designations





## 9.2 Valid Combinations

### Standard

| Single (Standard Speed) |                   | Dual (High Speed) |                   |
|-------------------------|-------------------|-------------------|-------------------|
| Capacity                | Model Number (5V) | Capacity          | Model Number (5V) |
| 128MB                   | AP-FM0128E10S5R-J | 256MB             | AP-FM0256E10D5R-J |
| 256MB                   | AP-FM0256E10S5R-J | 512MB             | AP-FM0512E10D5R-J |
| 512MB                   | AP-FM0512E10S5R-J | 1GB               | AP-FM001GE10D5R-J |
| 1GB                     | AP-FM001GE10S5R-J | 2GB               | AP-FM002GE10D5R-J |
| 2GB                     | AP-FM002GE10S5R-J | 4GB               | AP-FM004GE10D5R-J |
| 16GB                    | AP-FM016GE11S5R-J | 8GB               | AP-FM008GE10D5R-J |

| Capacity | Model Number (3.3V) | Capacity | Model Number (3.3V) |
|----------|---------------------|----------|---------------------|
| 128MB    | AP-FM0128E10S3R-J   | 256MB    | AP-FM0256E10D3R-J   |
| 256MB    | AP-FM0256E10S3R-J   | 512MB    | AP-FM0512E10D3R-J   |
| 512MB    | AP-FM0512E10S3R-J   | 1GB      | AP-FM001GE10D3R-J   |
| 1GB      | AP-FM001GE10S3R-J   | 2GB      | AP-FM002GE10D3R-J   |
| 2GB      | AP-FM002GE10S3R-J   | 4GB      | AP-FM004GE10D3R-J   |
| 16GB     | AP-FM016GE11S3R-J   | 8GB      | AP-FM008GE10D3R-J   |

### Extended Temperature

| Single (Standard Speed) |                     | Dual (High Speed) |                     |
|-------------------------|---------------------|-------------------|---------------------|
| Capacity                | Model Number (5V)   | Capacity          | Model Number (5V)   |
| 128MB                   | AP-FM0128E10S5R-ETJ | 256MB             | AP-FM0256E10D5R-ETJ |
| 256MB                   | AP-FM0256E10S5R-ETJ | 512MB             | AP-FM0512E10D5R-ETJ |
| 512MB                   | AP-FM0512E10S5R-ETJ | 1GB               | AP-FM001GE10D5R-ETJ |
| 1GB                     | AP-FM001GE10S5R-ETJ | 2GB               | AP-FM002GE10D5R-ETJ |
| 2GB                     | AP-FM002GE10S5R-ETJ | 4GB               | AP-FM004GE10D5R-ETJ |
| 16GB                    | AP-FM016GE11S5R-ETJ | 8GB               | AP-FM008GE10D5R-ETJ |

| Capacity | Model Number (3.3V) | Capacity | Model Number (3.3V) |
|----------|---------------------|----------|---------------------|
| 128MB    | AP-FM0128E10S3R-ETJ | 256MB    | AP-FM0256E10D3R-ETJ |
| 256MB    | AP-FM0256E10S3R-ETJ | 512MB    | AP-FM0512E10D3R-ETJ |
| 512MB    | AP-FM0512E10S3R-ETJ | 1GB      | AP-FM001GE10D3R-ETJ |
| 1GB      | AP-FM001GE10S3R-ETJ | 2GB      | AP-FM002GE10D3R-ETJ |
| 2GB      | AP-FM002GE10S3R-ETJ | 4GB      | AP-FM004GE10D3R-ETJ |
| 16GB     | AP-FM016GE11S3R-ETJ | 8GB      | AP-FM008GE10D3R-ETJ |

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## Revision History

| Revision | Date       | Description                       | Remark |
|----------|------------|-----------------------------------|--------|
| 1.0      | 11/24/2008 | Official release                  |        |
| 1.1      | 12/22/2008 | Cover page updated                |        |
| 1.2      | 12/29/2008 | Context revised                   |        |
| 1.3      | 02/11/2009 | Modified document layout          |        |
| 1.4      | 03/26/2009 | Updated valid combination wording |        |

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