RoHS Compliant

Serial ATA RAID Flash Drive

Specifications for SRFD

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[Preliminary]

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Features:

- **Interface**
  - Serial ATA 2.5 (Gen. 2)
  - SATA II, 3.0 Gbps
  - ATA command set compatible
- **Performance**
  - Burst read/write: 300 MB/sec
- **Capacities**
  - 1 GB+ for each slot with Ultra DMA mode support
- **Expansion**
  - 50-pin CF slot x 2
- **Mode**
  - FAST(RAID-0)
  - SAFE (RAID-1)
- **OS Support**
  - Microsoft Windows 2000 and XP
- **Auto Standby and Sleep modes supported**
- **Temperature ranges**
  - 0°C ~ 70°C for operation
  - -40°C ~ 100°C for storage
- **Supply voltage**
  - 5.0 V ± 5%
- **Form factor**
  - 2.5 inch
  - 7-pin SATA male connector
  - 15-pin SATA power connector
- **Low power consumption**
  - 510 mA (typical)
- **RoHS compliant**

Table of Contents

1. General Description

The Apacer 2.5” SRFD is the first SATA RAID Flash Drive introduced to the market. SRFD increases data reliability and security by utilizing an SATA interface and saving data into two CompactFlash cards. It offers capacity expansion, ultimate performance, reliability and simplicity with a variety of hardware RAID modes.

1.1 Functional Block Diagram

The Functional Block SATA RAID Flash Drive (SRFD) contains a SATA RAID Processor Unit, two CF media slots with PATA interfaces and a SATA interface to the Host.

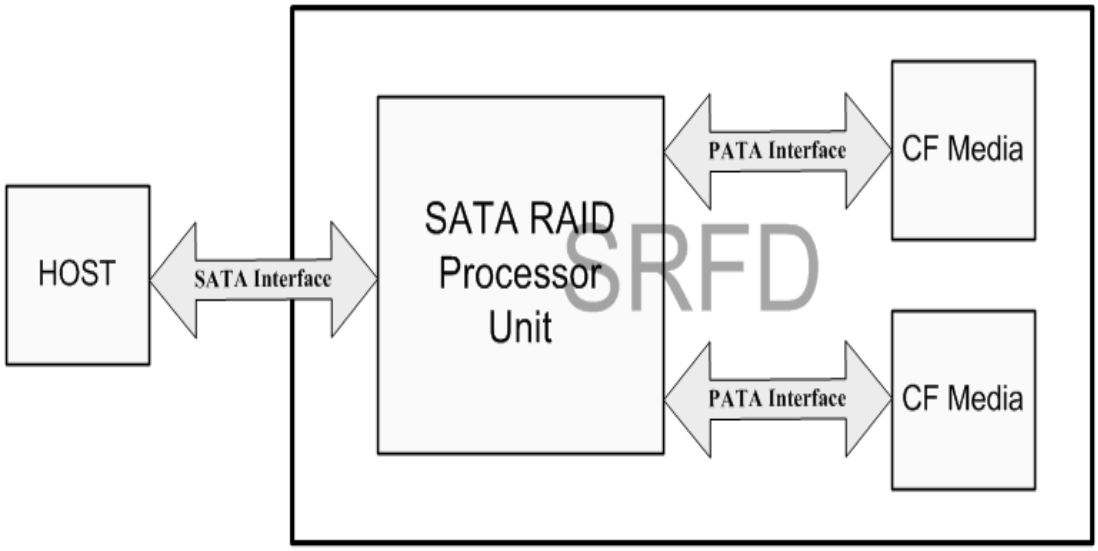
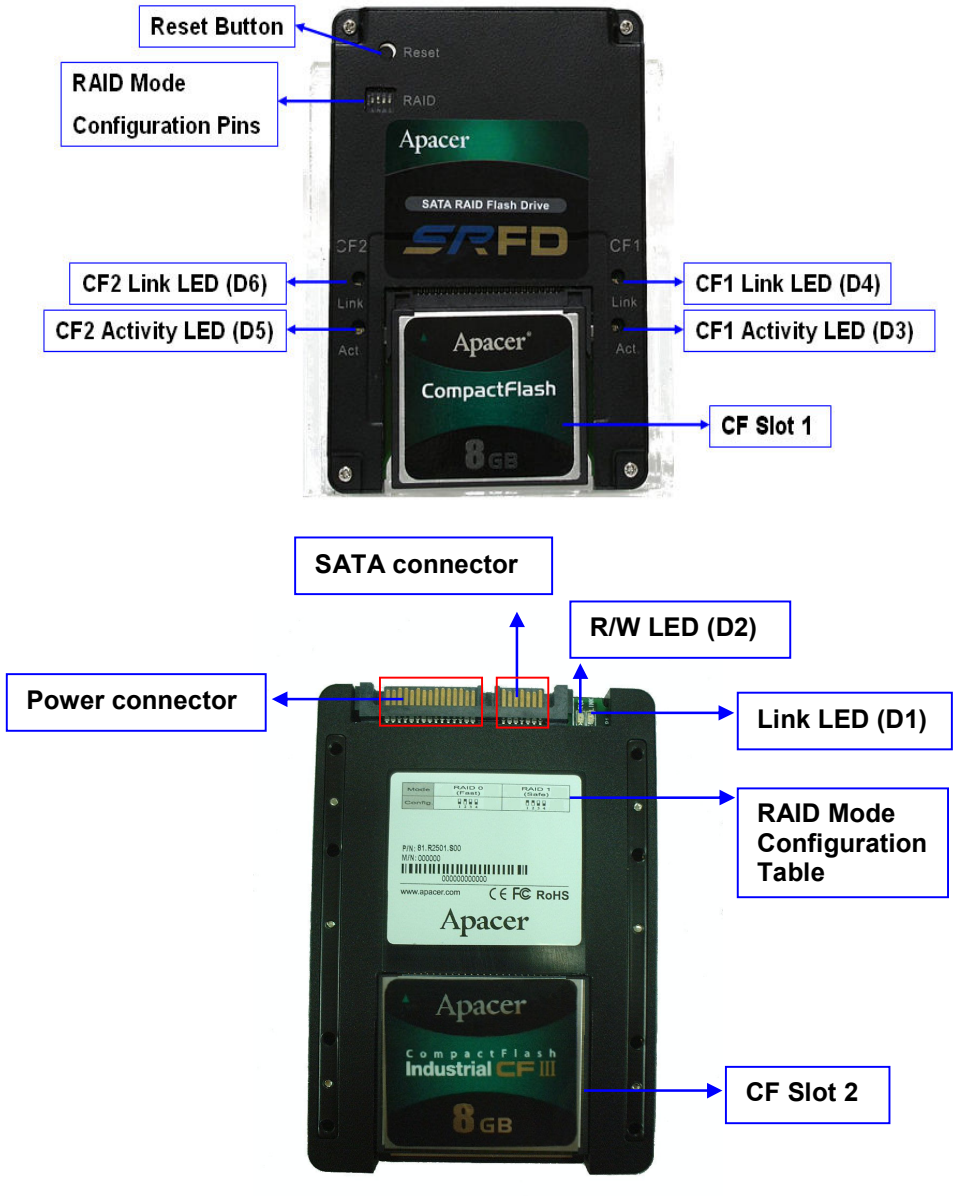


Figure 1-1: Functional block diagram

1.2 Appearance

This section describes the appearance of the SRFD. It contains the LED indication, mode configurations, expansion slots, and interfaces.



1.3 Mode Configuration

Apacer SRFD supports 4 static pins that can be used to program a normal operating state. The configuration of each node uses a combination of the Configuration pins and the Pushbutton (Reset) pin.

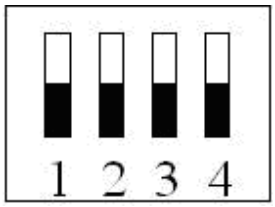
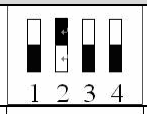
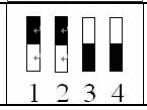


Table 1-1: Mode Configuration

Configuration Pin	1	2	3	4	Mode	Example
0100	0	1	0	0	RAID 0	
1100	1	1	0	0	RAID 1	

1.3.1 Definition

The following method can be used to define the configurations.

Configuration pins set to FAST (RAID-0), SAFE (RAID-1):

A. While the system is powered-up
   I. Any configuration change is ignored
   II. Physical drive change rules: no drivers accepted; in SAFE (RAID-1) mode, a single driver change will be accepted with normal driver rules (larger or equal to existing drive)

B. Upon power-up, but with no pushbutton (reset) press
   I. Any configuration change is ignored
   II. Physical drive change rules: no drivers accepted; in SAFE (RAID-1) mode, a single driver change will be accepted with normal driver rules (larger or equal to existing drive which must be present)

C. Upon power-up and momentary pushbutton (reset) pressed
   I. Only new configuration changes are explicitly accepted (if possible) and all new drives are explicitly accepted if there is a new configuration

1.4 LED Mode

The following table shows LED Mode status and descriptions.

Table 1-2: LED Status

H/D	Signal	Color	Indication	Description
Host	D1	Red	SATA Link	SATA Link ready
	D2	Green	Read/Write	Host/device Access (active)
CF 1	D3	Yellow	LED_D0_N1	See table as below
	D4	Green	LED_D0_N0	
CF 2	D5	Yellow	LED_D1_N1	See table as below
	D6	Green	LED_D1_N0	

Table 1-3: CF 1 and CF 2 LED

Description	LED_Dx_N1 (D3/D5)	LED_Dx_N0 (D4/D6)
Device Unplugged / No Power	Blink	Blink
Device Plugged (Idle)	On	Off
Device Plugged (Activity)	On	Flash (On)
Disk Rebuild (A Physical Partition is being Rebuilt; Safe Mode (RAID-1))	Blink	On
Disk Rebuild-Verify (A Physical Partition is being Verified; Safe Mode (RAID-1))	On	Flash (ON) Will appear as On
Error State: Incorrect Serial Number	Blink	Blink

2. Functions

2.1 Overview

- Compatible with SATA Gen1 and Gen2 host controllers
- OS independent, Driverless, Auto Configuration
- FAST (RAID 0), SAFE (RAID 1) support
- Embedded fast RAID Processor
- Virtualization engine to simplify and improve utilization of storage devices
- Ultra-fast 3Gbps host and device port capability

2.2 Intelligent SATA RAID Processor Unit

- Automatic Failover in RAID 1 mode
- Automatic Rebuild in RAID 1 mode
- Automatic RAID mode configuration
- 100GB/hr Rebuild speed without Host CPU loading
- High performance, reliability and simplicity with hardware RAID 0, 1 options
- Virtualized multiple storage devices into one or many storage units, e.g. multi-drive spanning, drive partitioning
- High-speed, native SATA II connection to host and device
- Device-to-device(s) copy to off-load host during rebuild
- LED drivers for status reporting
- Drive Splitting for multi-RAID partitions on a single volume with PM Aware Host

2.3 SATA

- 1x2 Port Multiplier Functionality
- 1.5Gpbs or 3Gpbs link rate with auto-negotiation
- Supports hot plug, drive roaming
- Supports host control of hard disk drive staggered spin-up
- Host side NCQ support

2.4 Architecture

- Features independent 8-KByte FIFO per Device Serial ATA channel for reads and writes
- High Performance data movement between all SATA Generation 2 ports
- Greater than 110MBps sustained reads in RAID 1 mode (limited by drives)
- Support store and forwarding

2.5 Applications

- PC
- DVR
- PVR
- Video Editing Systems
- eSATA Storage Target/Host

2.6 Virtualization

Virtualization is a mechanism, where the HBA can have an alternate view of the physical drives. The RAID Processor allows various access strategies to the connected Hard Disks and may be configured to represent n-drives as m-drives to the user. This provides the user with a simple way of partitioning storage resources according to use. For example, the processor could represent one drives as a single, large drive. Another option would be to make virtual storage resources according to reliability or performance requirements. One virtual target could be a mirrored set consisting of drives 1 and 2, or could be a striped set consisting of drives 1 and 2. Representing multiple device targets may only be performed with port multiplier aware host controllers.

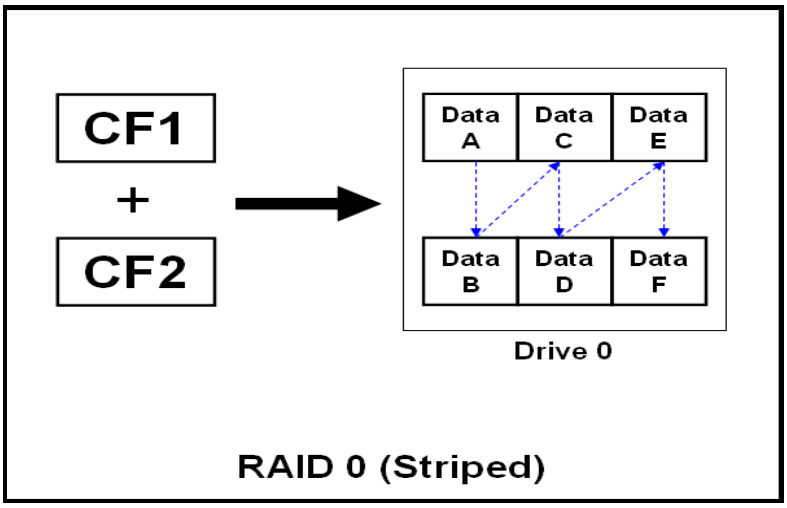
2.7 Modes

SRFD supports 2 modes: Fast (RAID-0) and Safe (RAID-1).

2.7.1 Fast (RAID-0) Mode

RAID 0 - RAID Level 0 is not redundant, hence does not truly fit the "RAID" acronym. This method splits the data over numerous drives but is seen as one drive by the operating system. If one drive fails though, all data becomes inaccessible. This level is commonly referred to as striping.

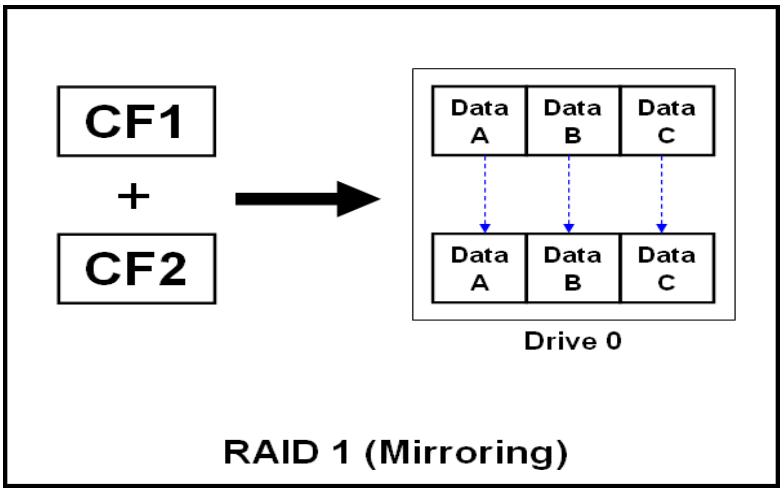
The RAID Processor supports a definition of Fast (RAID-0) set. The stripe size (chunk size) is set to 8 KB. The HBA (Host Bus Adapter) does not need to know anything about the physical arrangement of the data. To the HBA, the virtualized drive behind RAID Processor is a simple (normal) drive that just happens to be faster. All error handling etc. is managed by the Processor. The advantage of striping is double the data transfer throughput of a single physical drive. This applies to both read and write operations.



2.7.2 Safe (RAID-1) Mode

RAID 1- Mirrored Set (2 disks minimum) without parity. RAID-1 set is a combination of two physical partitions, where the data is “mirrored” among them. Provides fault tolerance from disk errors and single disk failure. Increased read performance occurs when using a multi-threaded operating system that supports split seeks, very small performance reduction when writing. Array continues to operate so long as at least one drive is functioning.

The RAID Processor supports a definition of Safe (RAID-1) set. The HBA (Host Bus Adapter) does not need to know anything about the physical arrangement of the data. To the HBA, the virtualized drive behind RAID Processor is a normal drive that just happens to be safer (fault tolerant). All error handling and Data rebuild is managed by the RAID Processor. The two physical partitions used for mirroring must reside on two different physical disks, as there is no benefit of mirroring the data on the same drive. The advantage of mirroring is essentially safeguarding the data in case of a single physical drive failure. For a read operation, the RAID Processor decides which physical partition to read from and for write, the data is written to both drivers. Note: There is no benefit of performance due to mirroring. Often the performance may suffer slightly, as the data will be transferred to the least common denominator of the two physical drives. The two physical partitions used for mirroring must reside on two different physical disks, as there is no benefit of mirroring the data on the same drive.



2.8 RAID-1 Racing

The Storage Processor improves the speed of RAID 1 (SAFE) mode by introducing RAID 1 drive racing. When reading a sector, both mirrored drives race and the first one to get the data supplies the information, lowering the average seek time.

2.9 Sector Recovery and Disk Rebuild

For Safe (RAID-1) volumes, the firmware implements three additional features to make the data more reliable, **Sector Recovery**, **Disk Rebuild** and **Disk Verify**.

2.9.1 Sector Recovery

For Safe (RAID-1) volumes, at any time, if the Storage Processor detects any read or write error, it automatically (without host intervention):

- Take the Physical Partition Off-line
- Attempt to copy the respective data from the other mirrored Partition (if available).
- If the re-write is successful, then the problem is solved before it got to be catastrophic.
- Bring the Physical Partition On-Line.

In case the problem still persists after re-write (Read-Verify fails), then it is assumed that Physical Partition on the Physical Disk is bad (and all spare sectors implemented by the HDD itself are depleted). In this event, this Physical Partition (with Error) will stay off-line. Other Physical Partitions on this HDD are still good and stay on-line. In addition, that HDD's LED will show the Error State. In the rare case, if there is another sector

recovery is needed, while the first one is not complete, then the new request is converted to a Disk Rebuild Request.

2.9.2 Disk Rebuild

First of all, the Disk Rebuild is really a Physical Partition Rebuild. Only then the Physical Partition spans the entire Physical Disk, the entire Physical Disk is rebuilt. Disk Rebuild is a procedure, to copy all of the contents from the “Good” Physical Partition to the “Broken” or “New” Physical Partition.
This is typically initiated on one of the following three events:

- Power Up (Scan if anything is pending)
- Physical Disk insertion (Assume, the inserted Physical Disk is good and ready to use).
- Another Sector Recovery or Disk Rebuild completes. During Disk Rebuild, the Physical Partition is not read from, but all writes are propagated to the drive.

2.9.3 Disk Verify

In addition to the Sector Recovery and Disk Rebuild, the Storage Processor also implements a Data Verification scheme. For sector Recovery, the Data Verification performed by Read-Verify Commands is automatically and always performed to make sure, the data is written correctly. In case of Disk Rebuild, this Data Verification is optional (selectable by GPI [1]). The firmware will read the status of this GPI pin and if “1”, it will perform a Verification cycle. Note: The drive is fully available for reads and writes, during the data verification process.

3. Pin Assignments

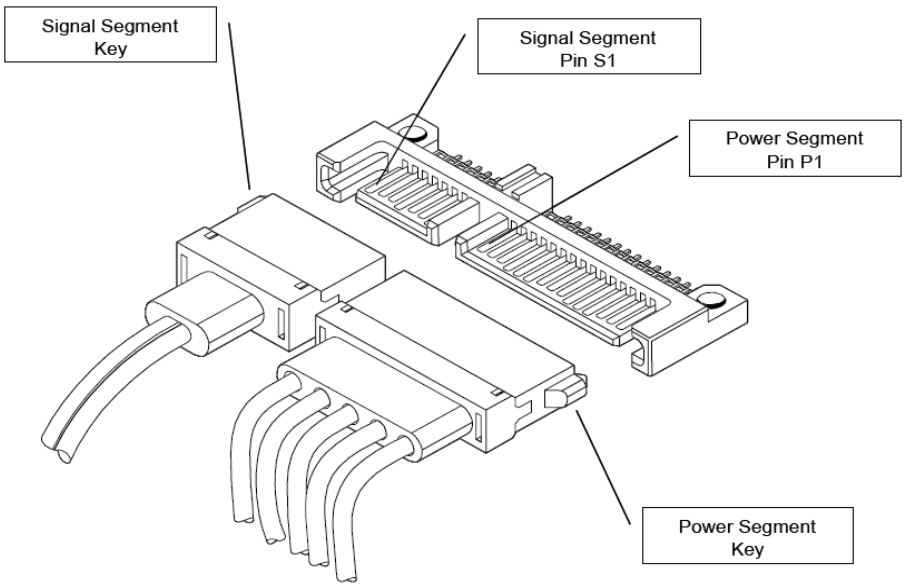


Table 3-1: Signal segment

Pin	Signal	Description
S1	Ground	
S2	RxP	Serial Data Receiver
S3	RxN	
S4	Ground	
S5	TxN	Serial Data Transmitter
S6	TxP	
S7	Ground	

Table 3-2: Power segment

Pin	Signal / Description
P1	Not Used (3.3V)
P2	Not Used (3.3V)
P3	Not Used
P4	Ground
P5	Ground
P6	Ground
P7	5V Pre-charge
P8	5V
P9	5V
P10	Ground
P11	Ground
P12	Ground
P13	Not Used
P14	Not Used (12V)
P15	Not Used (12V)

4. Environmental Specification

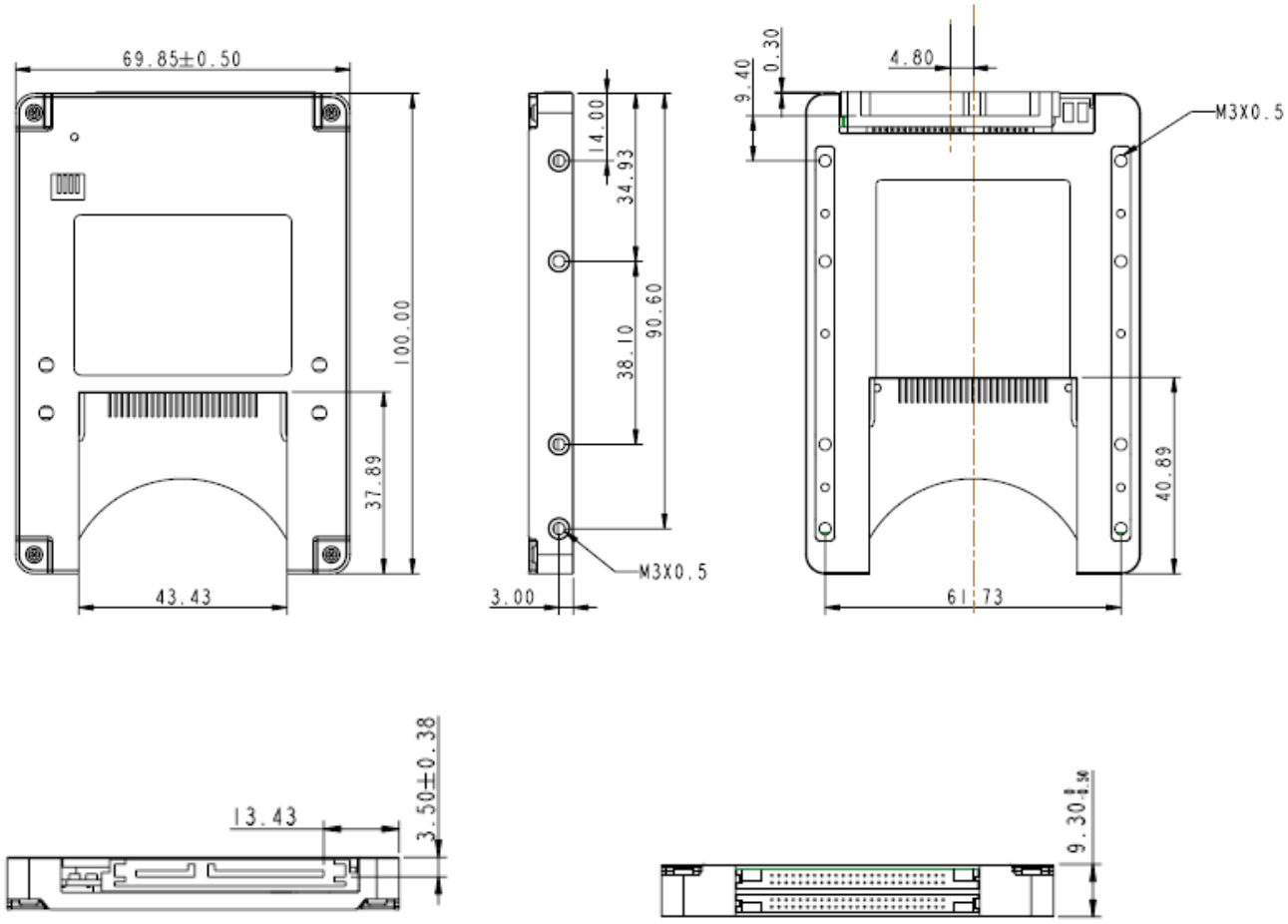
The environmental specification follows the US Military Standard MIL-STD-801F.

Table 4-1: Environmental Specifications (Plan)

Temperature	0°C ~ 70°C for operation
	-40°C ~ 100°C for Storage
Humidity	5% ~ 95%R.H (non-condensing)
Vibration	A) Sine wave: 5~55~5Hz , X,Y,Z axes B) Random: 10~2000Hz, 16.3g, X, Y, Z 3 axes.
Shock - Operating	A) Acceleration 1,500G , 0.5ms B) Peak acceleration 50G ,11ms

5. Physical Characteristics

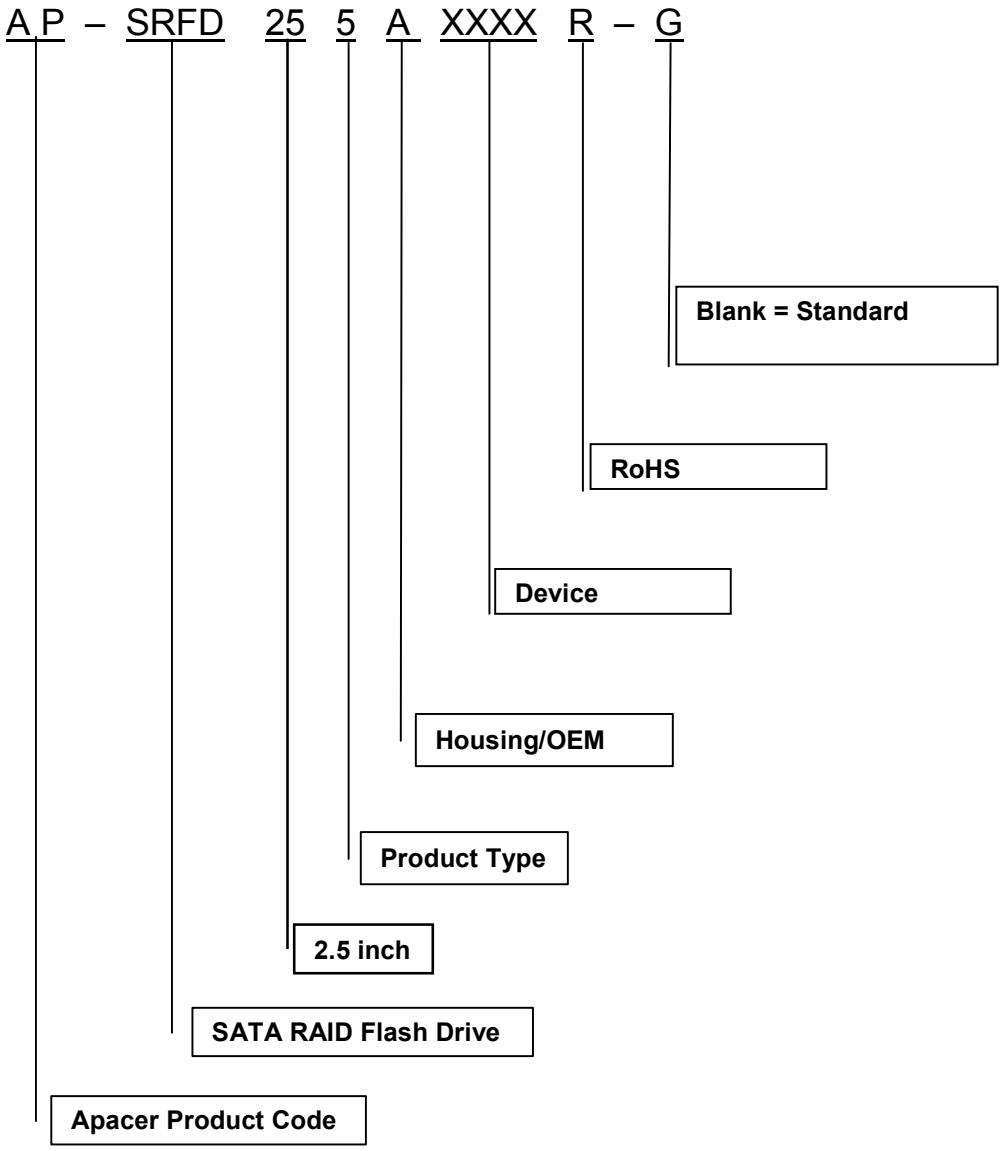
5.1 Dimension



Unit: mm
Tolerance: ± 0.2

6. Product Ordering Information

6.1 Product Code Designations



Revision History

Revision	Description	Date
0.1	Initial release. Preliminary specification.	Jan. 07, 2008
0.2	Updated features and function modes	Apr. 25, 2008

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