

# SUPERTALENT PCI EXPRESS RAIDDRIVE PERFORMANCE WHITEPAPER

PCI EXPRESS SOLID STATE DRIVE



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## 1.0 ABSTRACT

RAIDDrive is designed to break the throughput bottleneck in the storage subsystem by removing the bandwidth limitation of the SATA bus. The PCIe x8 interface used by RAIDDrive SSDs supports 2GB/sec bandwidth, over five times that of the SATA-II 3Gbps bus, and nearly three times greater than the SATA-III 6Gbps bus.

Using patented RAID architecture and NAND flash memory, RAIDDrive is able to achieve burst read speeds of up to 1.4GB/sec. A turbocharged cache system with up to 1GB of DRAM cache enables burst write speeds as fast as 1.2GB/sec. RAIDDrive, which houses four discrete SATA SSDs, comes in a custom aluminum enclosure measuring 257 x 107 x 25.4 mm. Higher capacity RAIDDrive models use the RAIDDrive Expander - a separate PCIe card - to hold a total of eight SATA SSDs.

## 2.0 PRODUCT OVERVIEW

### 2.1 PRODUCT FEATURES

- PCIe x8 lane host interface
- Burst Speed (max) : Read 1.4GB/s, Write 1.2GB/s
- Capacities up to 2TB (MLC), up to 1TB (SLC)
- Super Talent patent pending technology
- MTBF : >1,500,000 hours
- Dimension:
  - RAIDDrive: 257 x 107 x 25.4 mm
  - RAIDDrive Expander: 257 x 100.5 x 25 mm
- Battery backup module ready for RESxxxxE/M
- Operating Temperature : 5°C to 50°C
- Operating Humidity: 15-80% non-condensing
- Storage Temperature: -40°C to +70°C
- Storage Humidity: 5-90% non-condensing
- Built in error detection and correction
- Built in wear leveling algorithm
- Minimum 10 year data retention
- MLC or SLC Flash
- Power Consumption (typ):
  - RAIDDrive without RD Expander: 13W

- RAIDDrive with RD Expander: 18W
- Rugged Metal Case
- Warranty:
  - 1 year for RGSxxxx
  - 2 years for RESxxxx and RWSxxxx

## 2.2 RAIDDRIVE ARCHITECTURE

- Intel dual Core 1.2GHz IOP348 IO Processor for RAID core and SAS microcode
- 512MB On-board DDR2 SDRAM cache with ECC protection
- Write back cache support
- Supports up to 2TB capacity
- NVRAM for RAID configuration & transaction log
- Redundant flash image for adapter availability

## 2.3 RAID FEATURES

- RAID level 0 with RxS0xxx
- RAID level 5 with RxS5xxx
- RAID level is preset by customer order
- Instant Availability and background initialization
- Greater than 2TB per volume set (64bit LBA support)
- Field-upgradeable firmware in flash ROM

## 2.4 MONITORS AND INDICATORS

- System status indication through global HDD activity/fault connector, alarm buzzer
- SMTP support for email notification
- SNMP support for remote manager
- Enclosure management (SES2, SMP and SGPIO) ready

## 2.5 OPERATING SYSTEM SUPPORT

- Windows® 2000/XP/Server2003/Vista

- Linux
- FreeBSD
- Novell® Netware 6.5
- Solaris® 10 x86/x86\_64
- SCO Unixware® 7.1.4
- - Mac OS X 10.x (EFI Bios Support)

**2.6 ORDERING INFORMATION**

RAIDDrive is available in capacities up to 2TB, in RAID 0 or RAID 5 configurations, with MLC or SLC flash. Table 1 shows currently available part numbers and their specifics.

Product Family	Part Number	User Capacity	RAID Expander	RAID Function	Battery Backup	SLC/MLC
RAIDDrive GS	RGS0256M	256GB	No	0	No	MLC
	RGS0512M	512GB	No	0	No	MLC
	RGS01TM	1TB	No	0	No	MLC
	RGS01TE	1TB	Yes	0	No	MLC
	RGS02TE	2TB	Yes	0	No	MLC
	RGS5256M	192GB	No	5	No	MLC
	RGS5512M	384GB	No	5	No	MLC
	RGS51TM	768GB	No	5	No	MLC
	RGS51TE	896GB	Yes	5	No	MLC
	RGS52TE	1.75TB	Yes	5	No	MLC
RAIDDrive WS	RWS0256M	256GB	No	0	No	SLC
	RWS0512M	512GB	No	0	No	SLC
	RWS0512E	512GB	Yes	0	No	SLC
	RWS01TE	1TB	Yes	0	No	SLC
	RWS5256M	192GB	No	5	No	SLC
	RWS5512M	384GB	No	5	No	SLC
	RWS5512E	448GB	Yes	5	No	SLC
	RWS51TE	896GB	Yes	5	No	SLC
RAIDDrive ES	RES0256M	256GB	No	0	Yes	SLC
	RES0512M	512GB	No	0	Yes	SLC
	RES0512E	512GB	Yes	0	Yes	SLC
	RES01TE	1TB	Yes	0	Yes	SLC
	RES5256M	192GB	No	5	Yes	SLC
	RES5512M	384GB	No	5	Yes	SLC
	RES5512E	448GB	Yes	5	Yes	SLC

Table 1: Product Part Numbers and Descriptions

### 3.0 TEST SETUP

#### 3.1 TEST SYSTEM CONFIGURATIONS

We used two different configurations of RAIDDrive for these tests. The first drive was a 512GB RAIDDrive GS only with four integrated 128GB SATA drives, and is indicated as 4x in the benchmark charts. The second drive was a 512GB RAIDDrive GS with the RD Expander for a total of eight integrated 64GB SATA drives, and is indicated as 8x in the benchmark charts. All testing was done on an Asus P5Q3 Deluxe motherboard.

Product	RAIDDrive GS	RAIDDrive GS w/ RD Expander
# of Discrete SATA SSDs	4x	8x
Flash	MLC	MLC
Motherboard	Asus P5Q3 Deluxe	Asus P5Q3 Deluxe
Operating System	Windows Vista 32-bit	Windows Vista 32-bit

Table 2: Test System Configurations

#### 3.2 BENCHMARKING SOFTWARE

We used the following software to benchmark the RAIDDrive's performance.

- ATTO Disk Benchmark 2.34
- FD Bench 1.01
- PC Mark Vantage Pro 32-bit 1.0.0.0
- Crystal Disk Mark 2.2
- HD Tach RW 3.0.1.0
- HD Tune Pro 3.10
- Sandra 2008.5.14.24
- IO Meter 2008.16.18-RC2

### 4.0 TEST RESULTS

#### 4.1 ATTO DISK BENCHMARK

We tested the RAIDDrive in ATTO using a queue depth of 10 and a total data length of 256MB for the 4x test, and 128MB for the 8x (with RAIDDrive Expander) test. The small transfer sizes have slower transfer speeds, as we expected. The speed of RAIDDrive's caching system pays dividends for transfer sizes above 16KB. RAIDDrive achieves write speeds over 800MB/sec, in

## RAIDDrive PCIe SSD Performance

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some cases 250MB/sec faster than the read speed. The write speed is even faster for the 8x test, consistently scoring above 920MB/sec. This shows that the RAIDDrive Expander has a positive influence on write speeds.

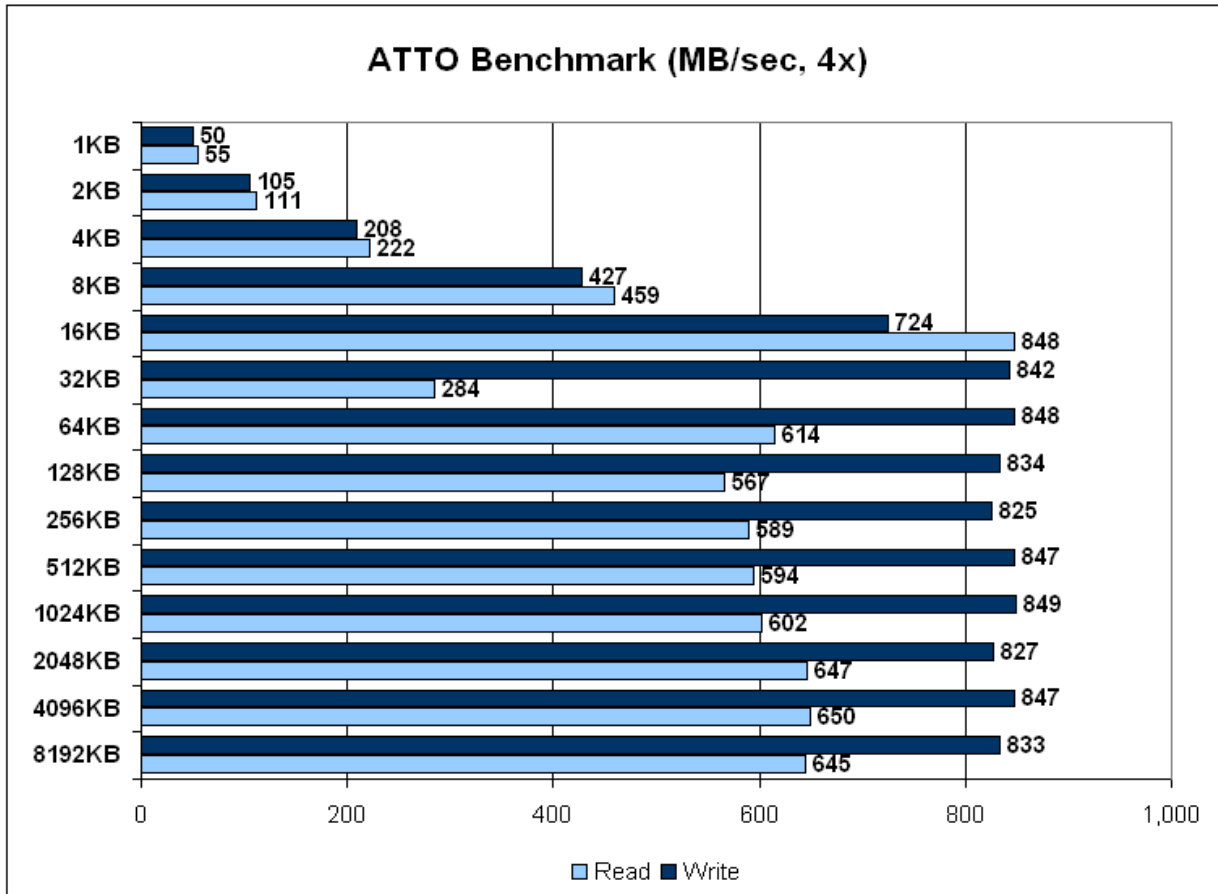


Figure 1: ATTO Disk Benchmark Scores, 4x



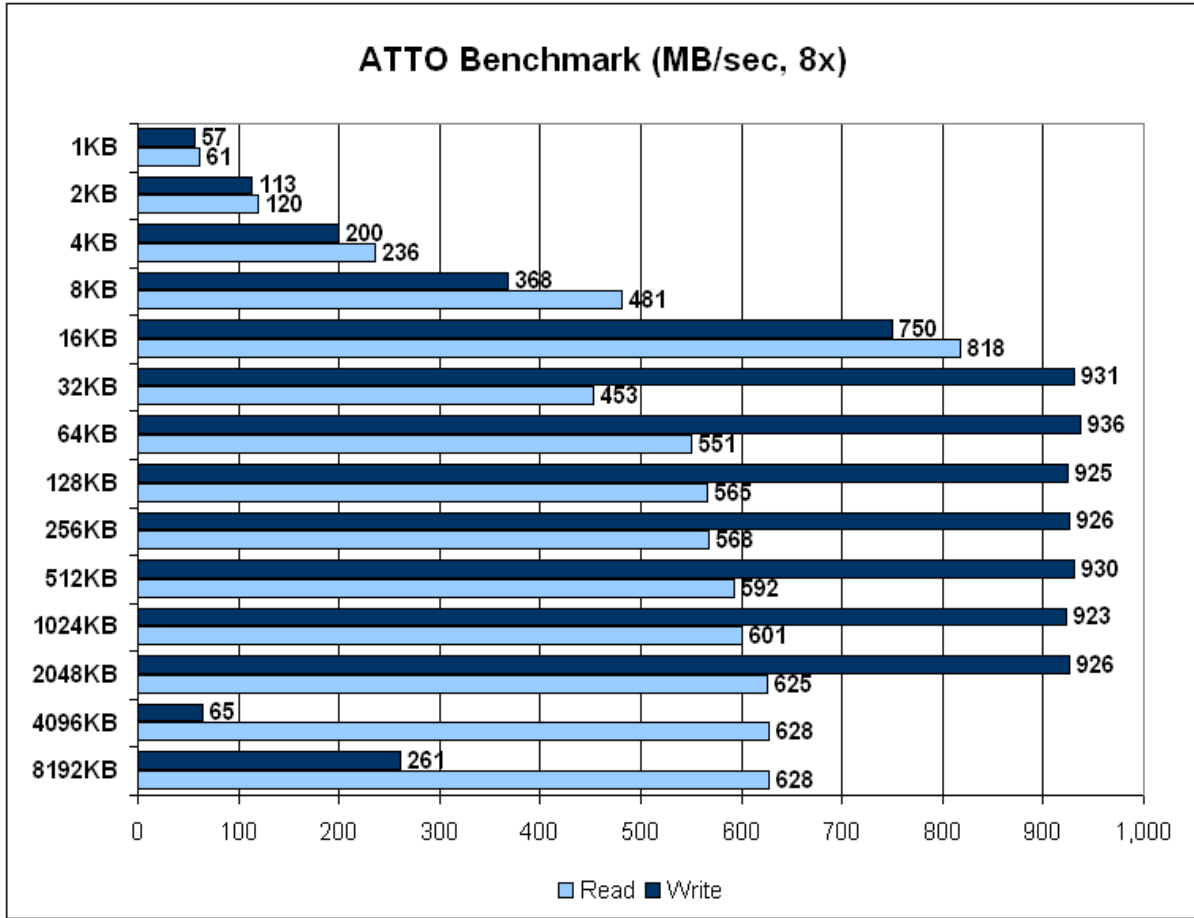


Figure 2: ATTO Disk Benchmark Scores, 8x

#### 4.2 FD BENCH

We tested the RAIDDrive in FD Bench in both 4x and 8x configurations with mixed results.

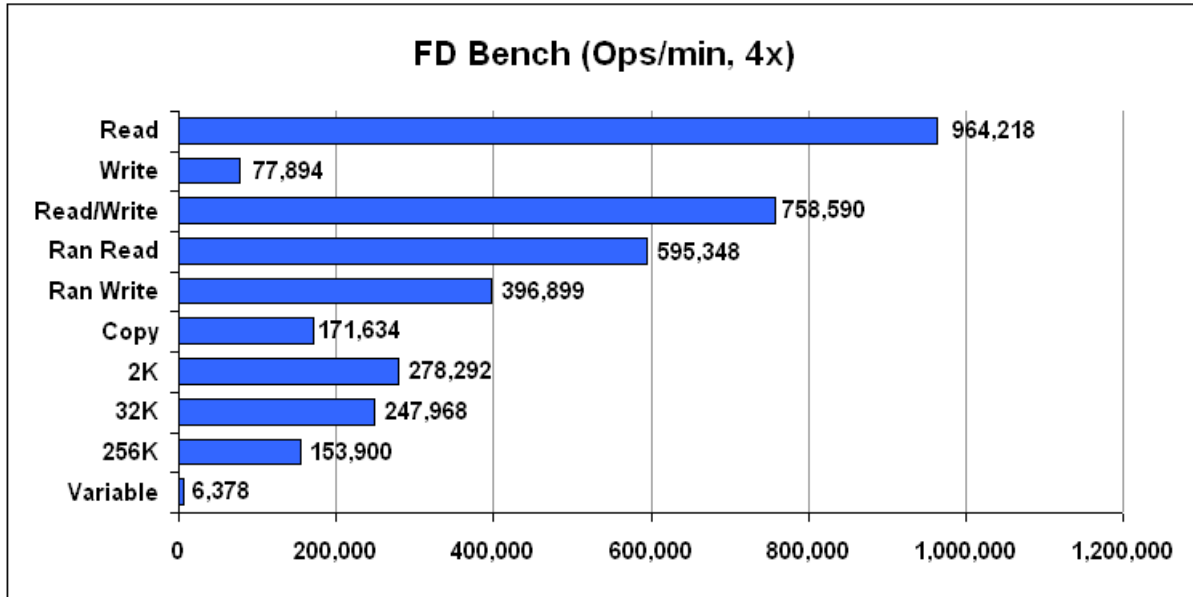


Figure 3: FD Bench Scores in Operations/min, 4x

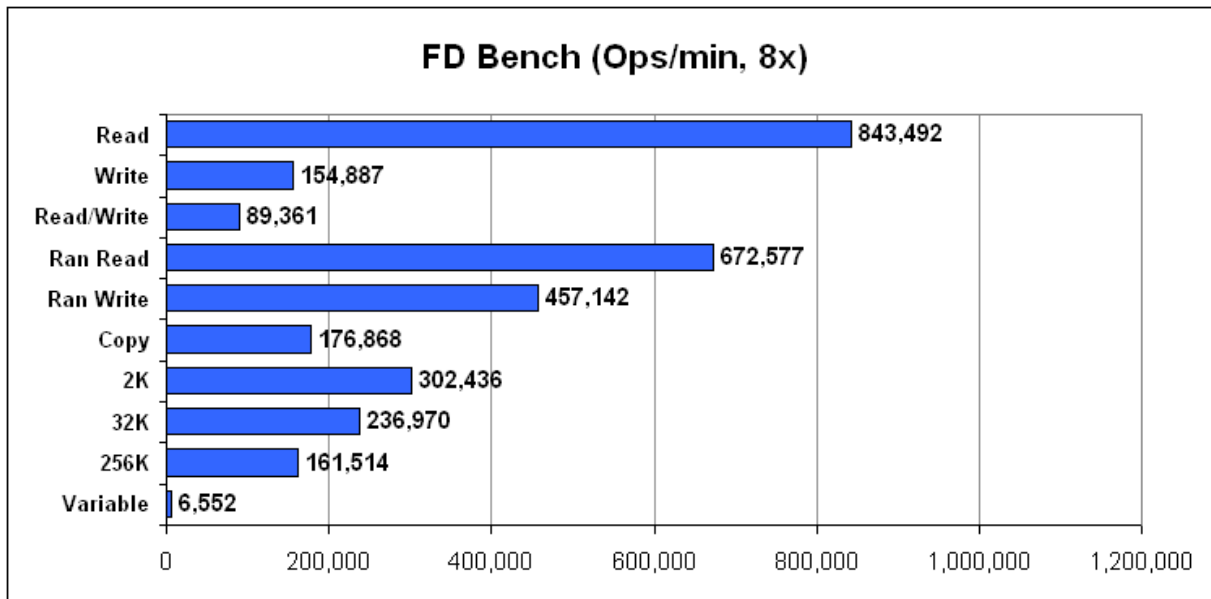


Figure 4: FD Bench Scores in Operations/min, 8x

#### 4.3 PC MARK VANTAGE

## RAIDDrive PCIe SSD Performance

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We tested the RAIDDrive in PC Mark Vantage in both 4x and 8x configurations. RAIDDrive posted excellent scores in Media Center, but relatively slow scores in other applications. The 4x configuration outpaced the 8x in most of these desktop applications.

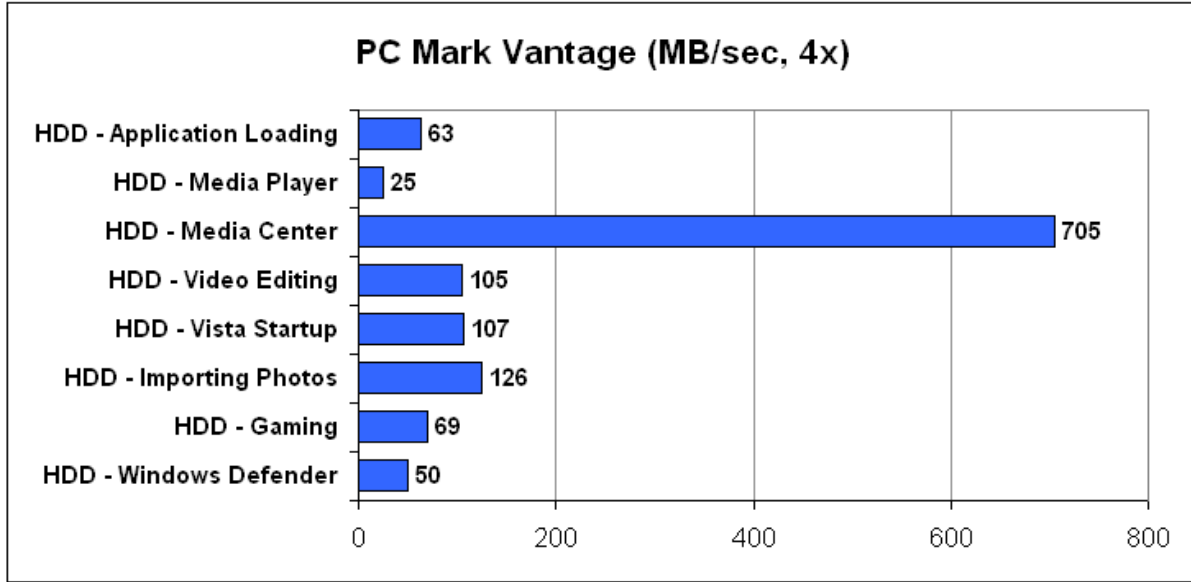


Figure 5: PC Mark Vantage Scores, 4x

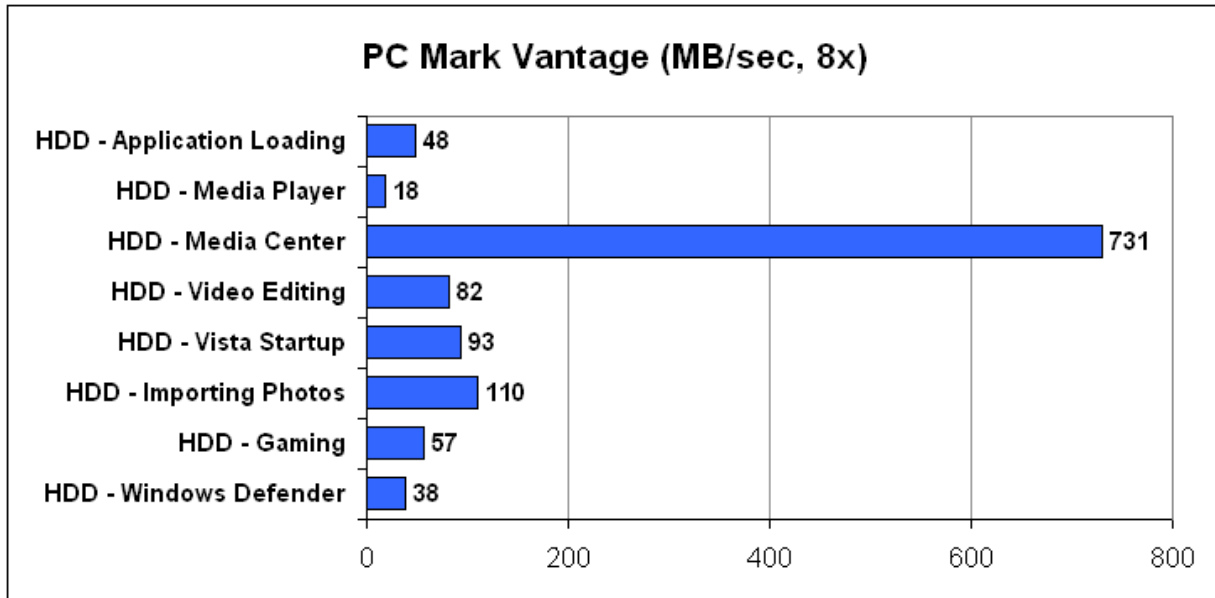


Figure 6: PC Mark Vantage Scores, 8x

4.4 CRYSTAL DISKMARK 2.2

In Crystal DiskMark we tested for five loops with both 100MB and 1000MB data sizes. The RAIDDrive shows its true potential in this benchmark. It reached sequential read speeds of 1397MB/sec and earned write scores above 1200MB/sec. Crystal DiskMark slightly favored the 8x configuration.

Since the RAIDDrive has 512MB of DRAM cache the performance for the 1000MB data size is considerably slower than with the 100MB data size. RAIDDrive can write data to cache very quickly, but after the cache fills up the speed decreases sharply. Because of the cache system the RAIDDrive delivers fastest performance when writing chunks of data that are smaller than 512MB.

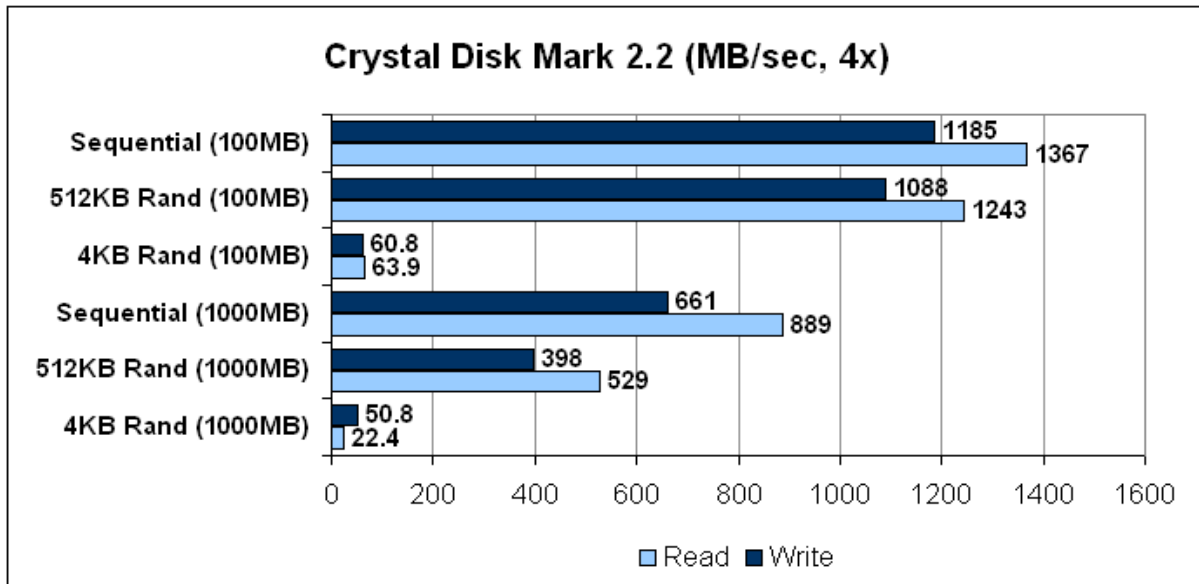


Figure 7: Crystal DiskMark Scores, 4x

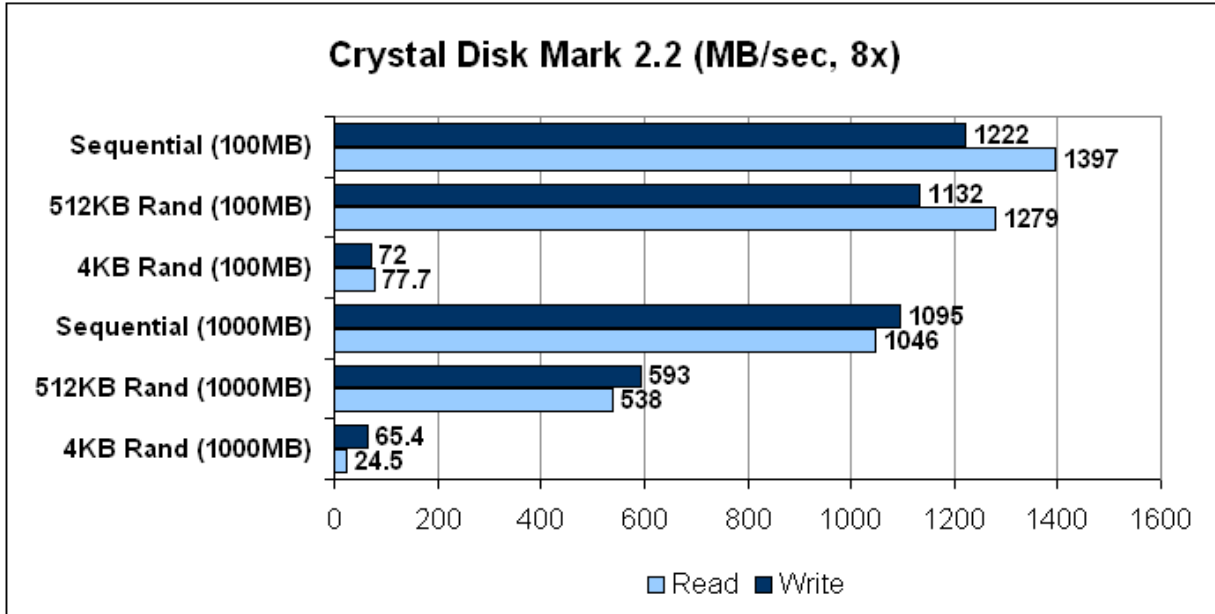


Figure 8: Crystal DiskMark Scores, 8x

#### 4.5 HD TACH RW

HD Tach showed average read speeds of around 600MB/sec and average write speeds of around 500MB/sec, with burst speeds approaching 1000MB/sec. Again the 8x configuration showed better performance than the 4x.

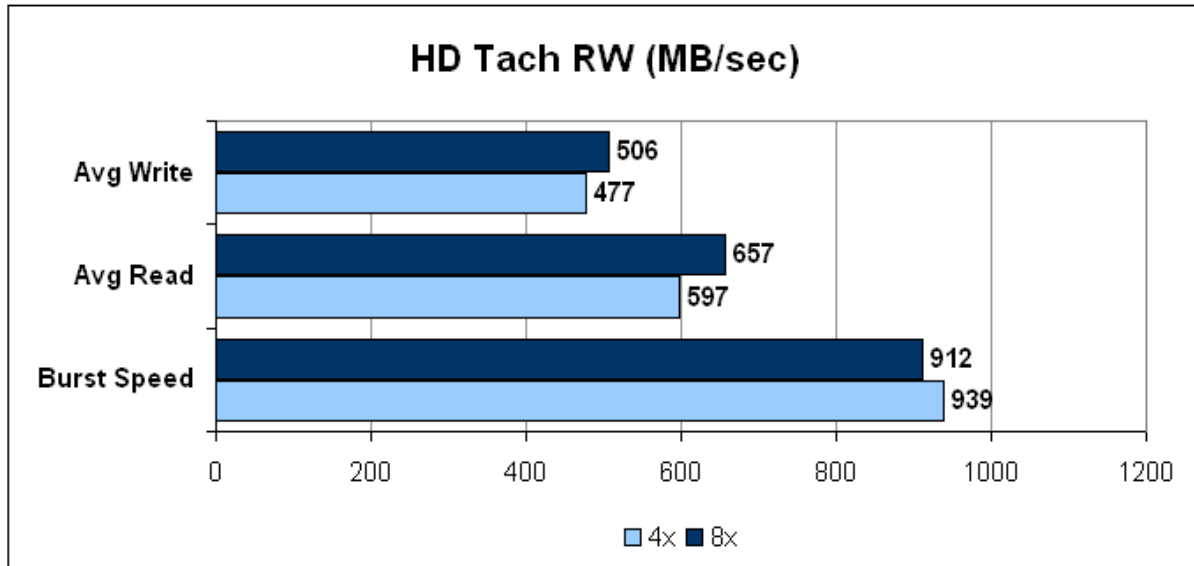


Figure 9: HD Tach RW Scores

#### 4.6 HD TUNE

We ran HD Tune with test spec setting: 4MB block size. HD Tune shows faster write speeds than read speeds. These results suggest that HD Tune knows how to leverage the RAIDDrive's DRAM cache to improve write performance.

RAIDDrive showed even better scores in the 8x configuration, reaching over 1000MB/sec write speeds.

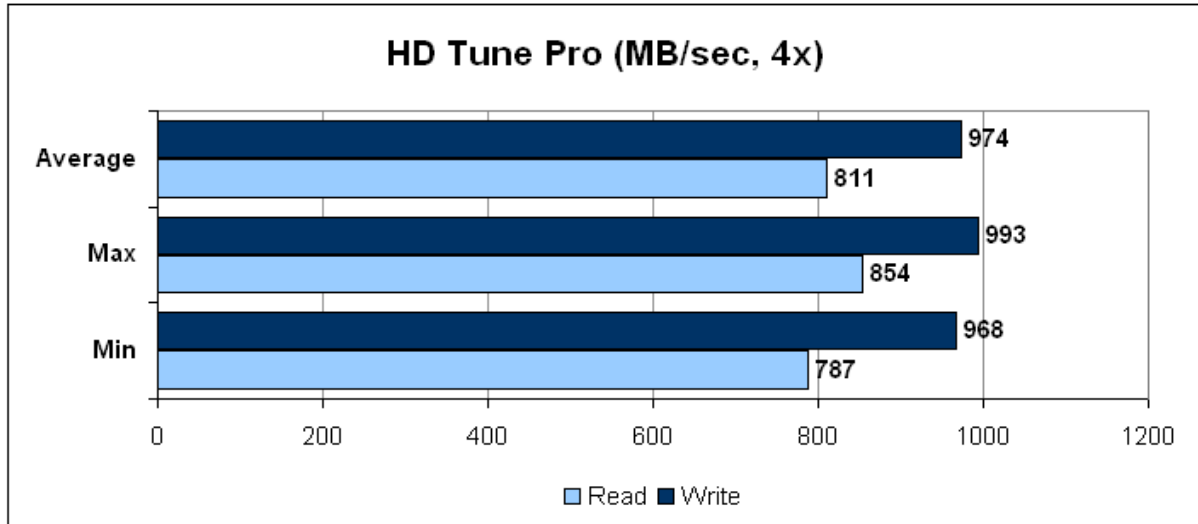


Figure 10: HD Tune Scores, 4x

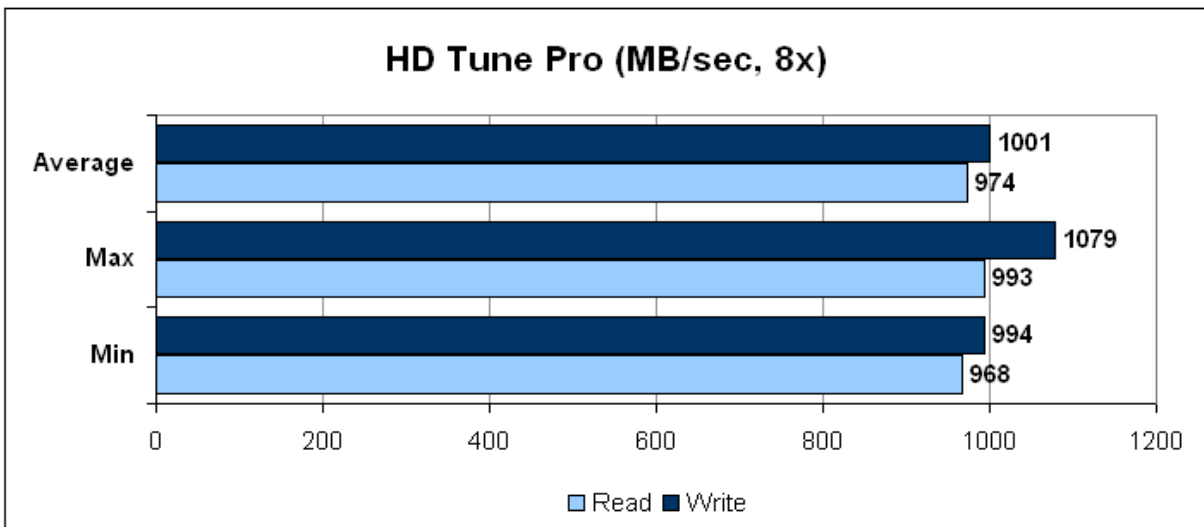


Figure 11: HD Tune Scores, 8x

4.7 SANDRA 2008

The Sandra benchmark demonstrated the upper end of RAIDDrive’s capabilities, attaining read speeds above 1500MB/sec and write speeds of up to 1270MB/sec.

Again the 8x configuration soundly beat the 4x scores in nearly every category. An interesting revelation of Sandra is the RAIDDrive’s random write speeds reaching 698MB/sec.

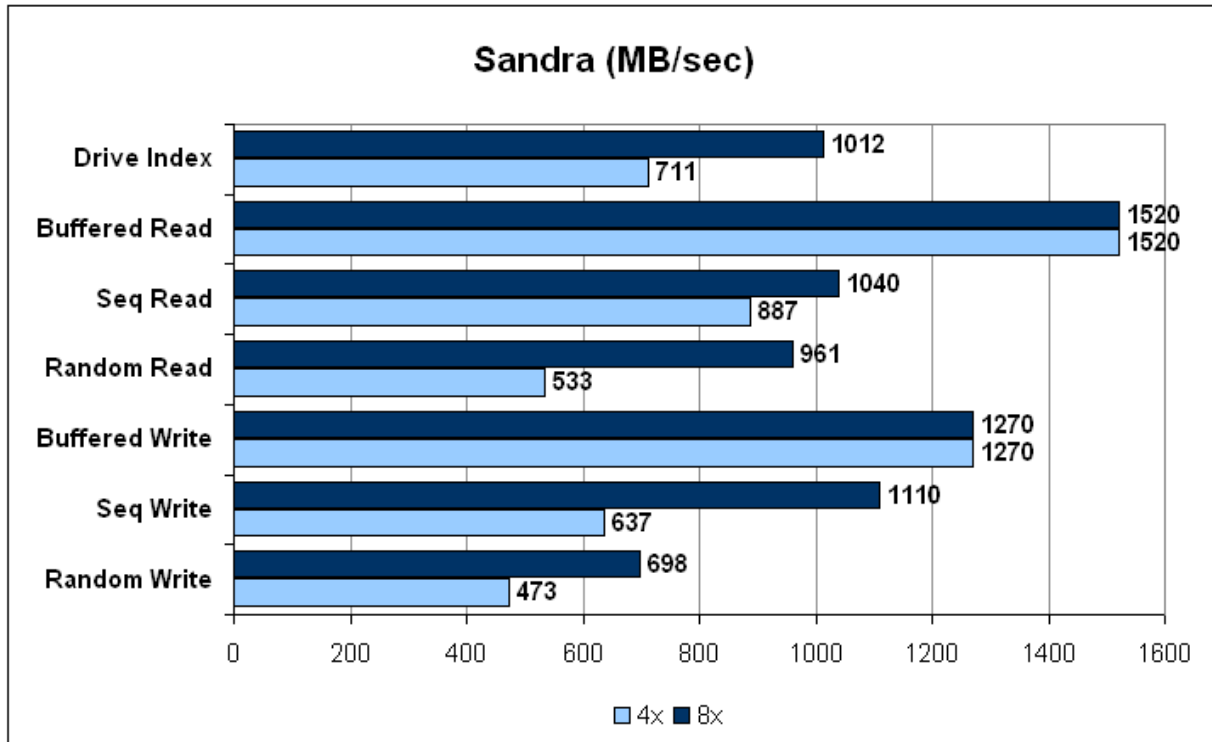


Figure 12: Sandra Scores

#### 4.8 IO METER



IO Meter tests the RAIDDrive's transaction speed in I/O operations per second. We ran this test with queue depth settings of 16 and 32. The larger queue depth tended to offer the highest transaction speeds. In 4KB sequential read and write speeds RAIDDrive hit about 80,000 IOPS.

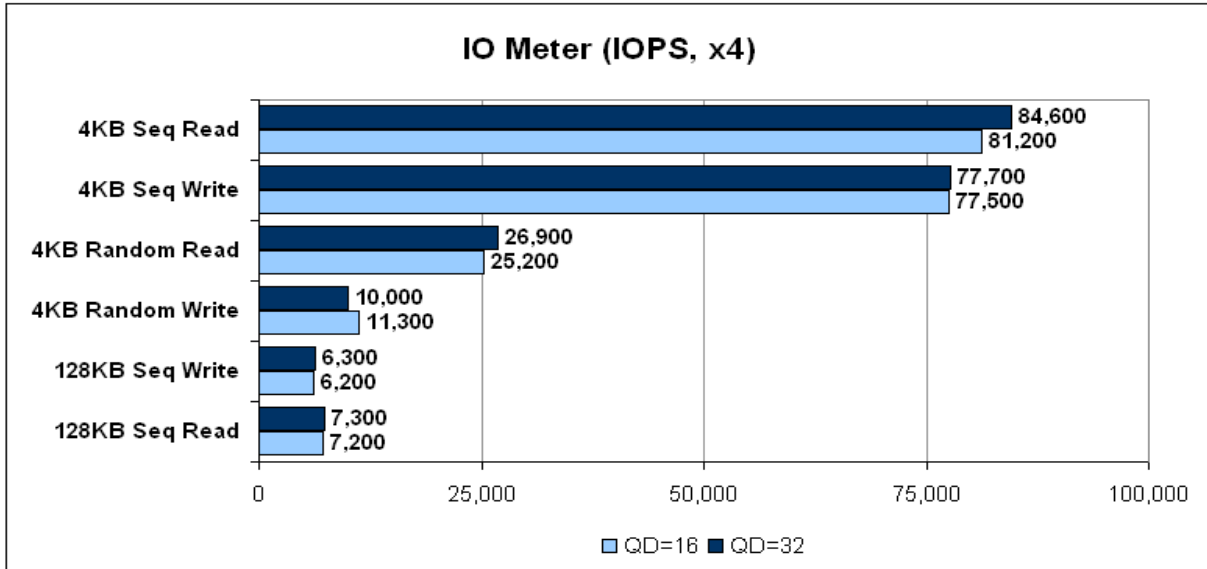


Figure 13: IO Meter Scores, 4x

## 5.0 CONCLUSION

RAIDDrive does indeed break the storage performance bottleneck. It easily attains sequential read and write speeds of 600 to 900MB/sec with burst speeds of 1200 to 1500MB/sec, as shown in the battery of eight different benchmarks we conducted. In many cases RAIDDrive even showed faster speeds writing than reading, thanks to its turbocharged DRAM cache.

RAIDDrive reaches maximum performance when configured with the RAIDDrive Expander that supports a total of eight integrated SATA SSDs. The high speed SAS interconnect between the RAIDDrive and the RD Expander does not inhibit performance.

Perhaps most important, RAIDDrive is capable of supporting up to 80,000 IOPS. In IOZone tests RAIDDrive scored over 32,000 random read IOPS with 4KB file sizes. This makes it ideal for enterprise server applications that require exceptional transaction rates.

FOR MORE INFORMATION

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