IOPS/Power Failure Protection Benchmarks

IOPS: Input/Output Operations Per Second

IOPS, input/output operations per second, is a standard unit of measurement for the maximum number of read and write operations per second to a storage location, such as hard disk drives, solid state drives, and storage area networks. It is used as a benchmarking tool to measure performance on the drive being tested. IOPS is often measured with a testing tool called IOMeter (originally developed by Intel) which can help predict how much load a network can handle before performance is adversely affected. Sequential operations will access locations on the storage device in a contiguous manner and are typically associated with larger data transfer sizes, such as 128 KB. On the other hand, random operations will access locations on the storage drive in a non-contiguous manner with smaller data transfer sizes, such as 4 KB.

To measure IOPS and performance, Crystal Disk Mark and IOMeter were used to test two different drives: SQFlash and Transcend. Both drives were tested with the same platform in Windows OS. The results can be seen in the chart below:

Fig 1. Performance I: Crystal Disk Mark performance comparison between SQFlash 830 vs Transcend 370 model

For performance I, the utility used is Crystal Disk Mark which tests the read/write performance. The higher the number, the better the performance.

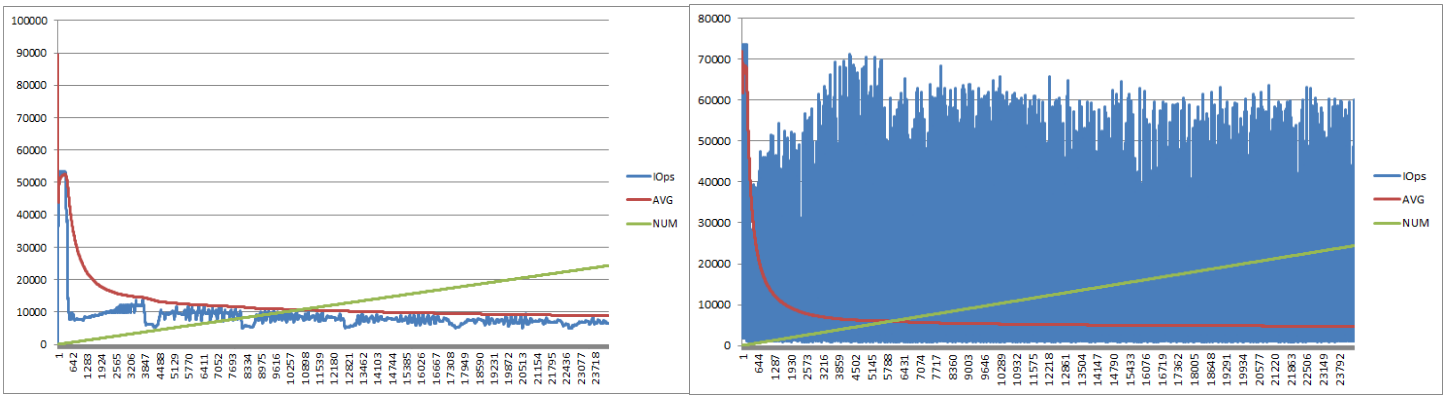


Fig 2. Performance II: IOMeter performance comparison of average IOPS and the stability

From figure 2, the X axis is the size of data write into SSD and Y axis is the throughput while red line is the average of IOPS and blue line is the actual raw data.

Figure 2 shows that the average IOPS on the SQFlash drive is much more stable with fewer fluctuations in measurement compared with the Transcend one. In industrial applications (ex: RF recording or video recording application), IOPS stability is important since it helps minimize the possibility of the temporary stuck state and guarantee the whole system can operate smoothly.

To conduct the test, A data pattern is continuously written on two different drives, Advantech 830 and Transcend 370, for 8 hours and the write throughput is sampled and recorded every second for a total of 24400 IOPS records. Then the each IOPS record per second (actual throughput raw data) is compared to its average throughput to generate the table below. For example, 3416 reading (out of 24400) fall at 41-60% of Advantech 830 average written throughput (see the one highlight in red)

	% of actual IOPS vs average speed								
	<20%	21 -40%	41-60%	61-80%	81-100%	101-120%	121-140%	140-160%	>160%
Advantech 830	0	0	0	3416	9272	7808	2196	1708	20
Transcend 370	7	1879	20740	26	20	24	11	24	1668

For the Advantech 830 drive, the minimum IOPS throughput data is 62% of average speed and maximum IOPS throughput data is 175%. About 70% of the throughput data (9272+7808 times vs 24400 times of sampling) fall within 80 – 120% of average write speed. The effective written throughput fall is around 100% of average.

On the other hand, the throughput reading of Transcend drive spread out; minimum is 3% of average speed (i.e., might cause temporary stuck due to low throughput) and the highest is 1668%. Among all of 24400 throughput data, roughly 85% of them are between 41-60% of average speed and 7% of the throughput are very high spikes which boost the average. The effective written through put fall between 40% – 60% of average. This is especially true for devices which requires stable written throughput like digital video recording.

Power Failure Protection Test

Power failure protection is one of the most important criteria for industrial flash storage application. Therefore, how to prevent

Many drives are designed with DDR internally as a storage buffer to boost performance so the DDR has become part of the storage unit. Since the DDR cannot store data when power is shut down, it becomes a risk when power is suddenly cut off during operation and can cause data lost or corruption.

Other drives are designed with extra capacitors in SSD circuit to extend the power off sequence timing for gaining additional time to make sure the data storage in DDR buffer can write into Flash successfully when sudden power failure happens.

However, considering the instability of super capacitors in extremely high or low temperature and its degradation from time to time, this may not be the best solution either.

What SQFlash offers is their design of the structure of SSD, making DDR as a part of processing unit instead of the storage buffer. This way, the data can only be written into flash IC directly. This design helps to guaranteed there is no data lost or corruption when sudden power failure and also increase computing throughput of SSD to boost overall performance without sacrificing data integrity.

Advantech's power failure protection test is to simulate the sudden power failure situation when data writing and programing into the flash IC pages. It shows the reliability, stability, and quality of the disk.

This stress test verifies the result of power failure on the NAND flash by issuing a command to cut the power supply to the chip at specific moments. After power is applied, data is verified and compared, sequential writing of data begins, and power is cut. The criteria for passing is for the data compared to be correct; if the data compared is incorrect, it is considered failed. The test is ran 35,000 times.

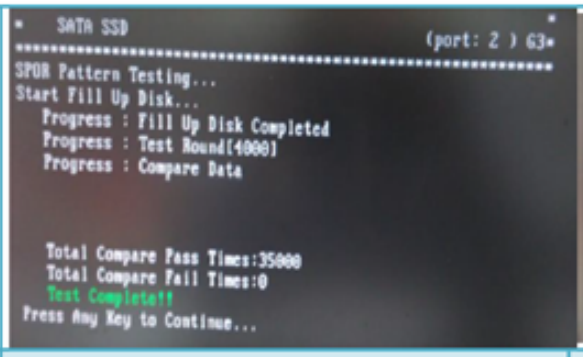
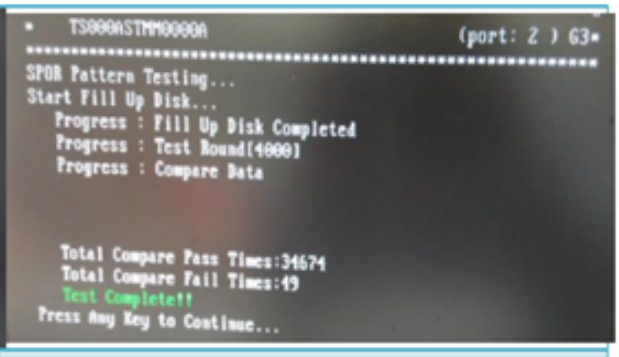
Power Failure Protection		
Pair Page Fail Rate	~0 %	~0.14 %

Fig 3. Power failure protection test result comparison

Based on the test results, Advantech's SQFlash (830 SATA III 6.0Gb series) drive passes the power failure test 35,000 times without any errors occurring. On the other hand, the second drive (Transcend 370 model) with capacitor in circuit (power shield) for resulted in about 50 errors after 35,000 test cycles (See Fig3).