TECHNOLOGY PAPER

FROM SEAGATE

INTELLIGENCE

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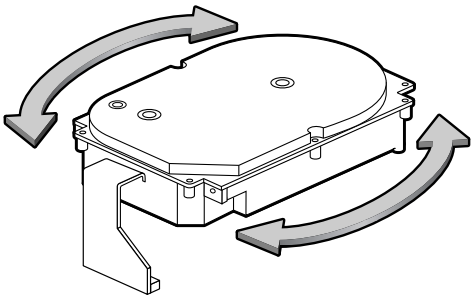
Seagate

Seagate's Advanced Multidrive System (SAMS) Rotational Vibration Feature

Seagate's Advanced Multidrive System (SAMS) is a disc drive design methodology focussed on meeting the unique demands associated with multidrive systems. Having multiple devices on a bus (SCSI/FC) forces the disc drive to perform in a manner differently than a single-drive (ATA/IDE) configuration. SAMS takes into account often-overlooked factors that make a difference in multiple drive applications. The areas of the drive involved with SAMS include module design, code development, servo systems, rotational vibration, interface efficiencies and more.

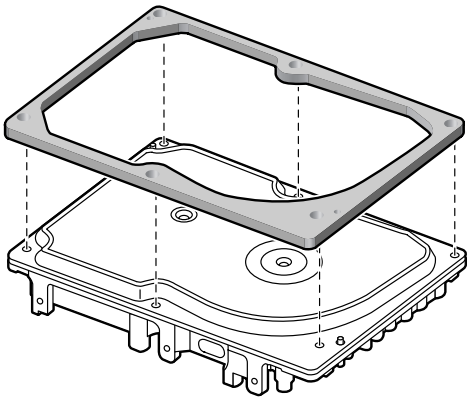
The purpose of this paper is two-fold:

- To introduce and educate the reader on a subset of SAMS called Rotational Vibration
- To show how Seagate's Enterprise drives are superior to the competition with respect to operating performance in a heavy RV environment



Rotational Vibration (RV) is a twisting/torquing type action experienced by a disc drive inside a cabinet. Twisting in the orientation as shown is the most sensitive mode of vibration for a disc drive. If RV is not taken into account in the design of the drive, the force of RV can push the head off track, causing missed revolutions and delays in data transfers. Tests have shown significant reductions (over 50 percent) in performance due to RV.

The main sources of RV energy are: 1) the drive's self-actuation 2) additional drives inside the cabinet accessing data and 3) external forces acting on the cabinet. The recently announced Cheetah® 36LP/73 drives incorporate an Inertia Ring into the module design that limits the transfer of RV energy between the drive and the chassis. The Inertia Ring reduces the drive's susceptibility to RV, maintaining performance levels inside of cabinets. Tests with and without the Inertia Ring show a 20 percent improvement in IOs per second (IOPS—Input/Output Operations Per Second).



Mild levels of RV can force the head off track and cause delays in accessing the data, which reduces performance in terms of IOs per second. Excessive levels of Rotational Vibration can force a disc drive's servo system to inadvertently go off track, causing a servo error and potentially causing data loss due to writing too close to an adjacent track. Seagate's disc drive designers both understand and account for RV to achieve both performance objectives and data integrity goals.

Seagate-Exclusive Patent Pending

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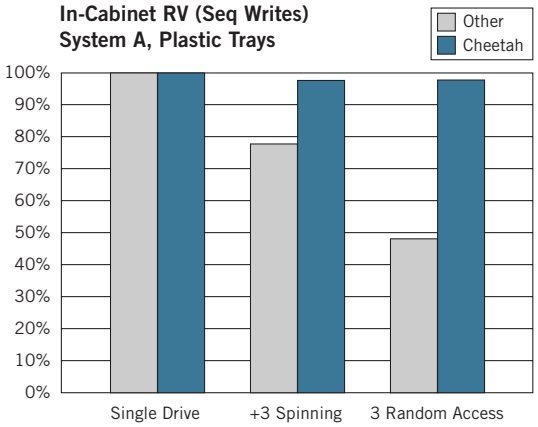
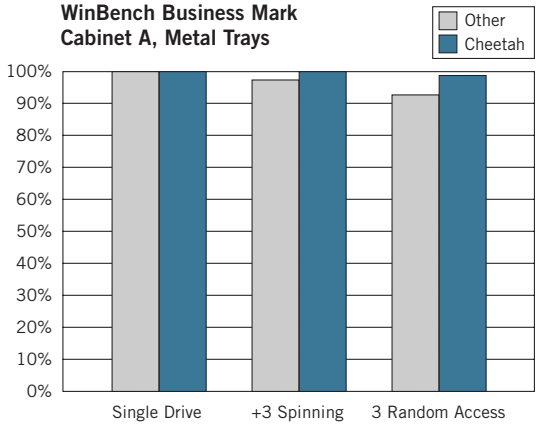
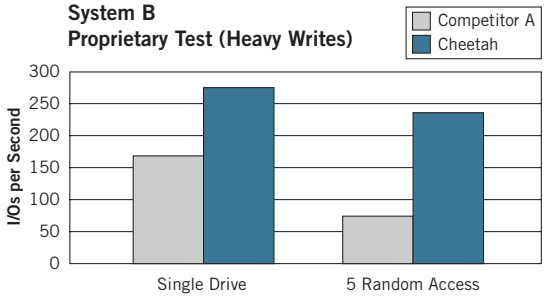


As a point of departure, System A (actual name cannot be disclosed) was chosen because it shows the negative effects of RV quite clearly. The manufacturer of System A happens to be among the top 10 computer manufacturers and is currently in use at numerous end-user sites around the world. Although these sites may be functional, the ones populated with Seagate's competitor's drives are not performing anywhere near the level they should be. The performance levels found in cabinet A reveal significant reductions due to RV in multidrive applications. As you can see, severe degradation in performance occurs when the competitor's drives are used. You can see that when a single drive is running alone performance is not a problem, but as soon as the other 3 drives in the cabinet are turned on, performance drops below 80% of its original performance level. When 3 other drives start accessing data, the performance of the competitor's drive falls even further to about 40 percent of what it should be. However, in the exact same tests, the performance of Seagate's Cheetah drive did not waiver!

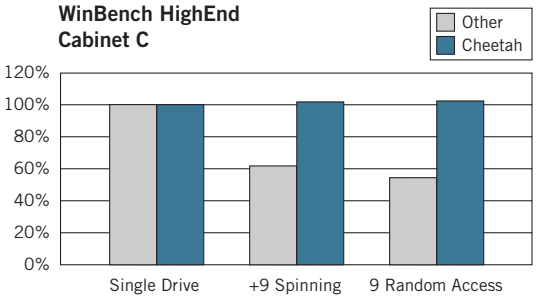


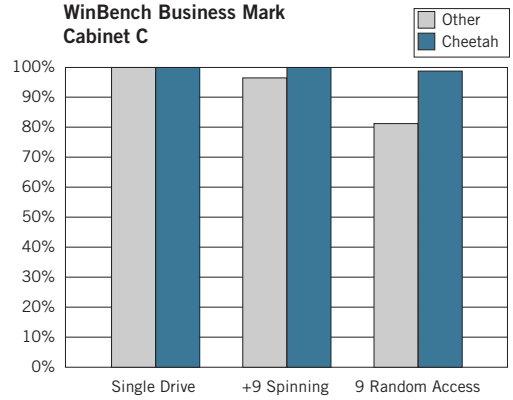
One of the reasons why the other drive degraded so severely in system A was that the slides (trays) used in mounting the drives are made of plastic. This particular manufacturer later upgraded cabinet A with metal trays (many plastic trays are still in use elsewhere today). Upon swapping out the plastic slides (trays) with more modern metal ones, the severity of RV is somewhat lessened, but the fact of the matter is that a degradation of 8 percent and 10 percent was still measurable on WinBench Business Mark.The Cheetah, however, continues to hold steadfast, showing no sign of performance degradation under the same RV environmental conditions as the competitor's drive.



System B is made by a manufacturer that is once again in the top 10 computer companies in the world, but it was one of the worst cabinets tested with respect to RV. The test executed in this system is proprietary, but we know it executes numerous write commands. In addition to their RV advantages, Cheetah and Barracuda® drives also have significant advantages over the competition in write performance. Once again we see a reduction in performance to over half of what it should be on the competitor's drive, whereas Seagate's Cheetah holds to over 90 percent of its non-RV level.

System C is an Ultra2 SCSI cabinet sporting ten drive bays, nine of which were integrated with disruptive disc drives. Disruptive means the function of these nine drives was simply to spin at 10,000 rpm for the first half of the test and then perform Random Access operations to provide RV input to the single drive tested by WinBench. The test drive was located in the center of the cabinet with 4 disruptive drives above it and 5 below. WinBench 99 was run on both a Cheetah18LP and a competitor's drive. Once again you can see the other drive's performance drops to nearly half as soon as the other drives inside the cabinet are turned on. The Cheetah's performance, on the other hand, does not waiver one iota.

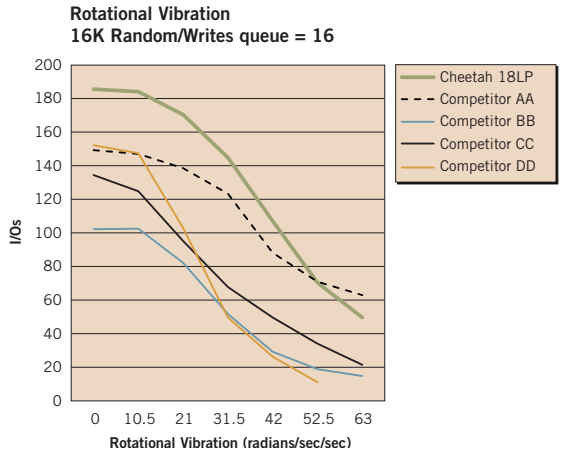


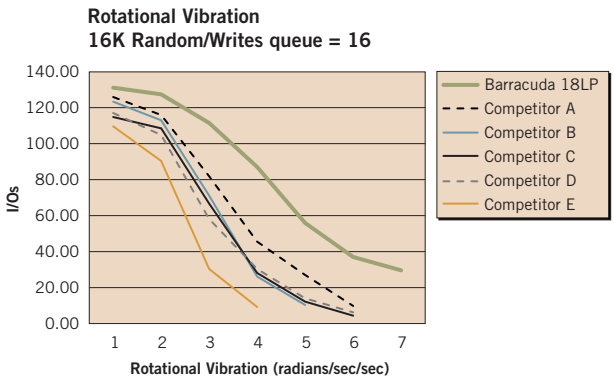


These tests clearly show that unless Rotational Vibration is taken into account in the design of the disc drive, the in-cabinet performance of the drive will be compromised to some degree.

You can see that Rotational Vibration is a real factor that negatively affects the performance of disc drives. However, not all disc drives are created equal with respect to their ability to stay on track in RV environments. To show this in a more formal fashion, we have taken Seagate Enterprise drives (Cheetahs and Barracudas) as well as the comparable competitor's drives and tested them on an RV test stand. An RV stand is a circular plate to which the drive is bolted down that rotates back and forth at various speeds and frequencies. The drive's write performance is monitored during the test at various levels of RV input. The output of the test is the number of IOPS (Input/Output Operations Per Second) as RV energy (radians per second squared) is increased on the test fixture.

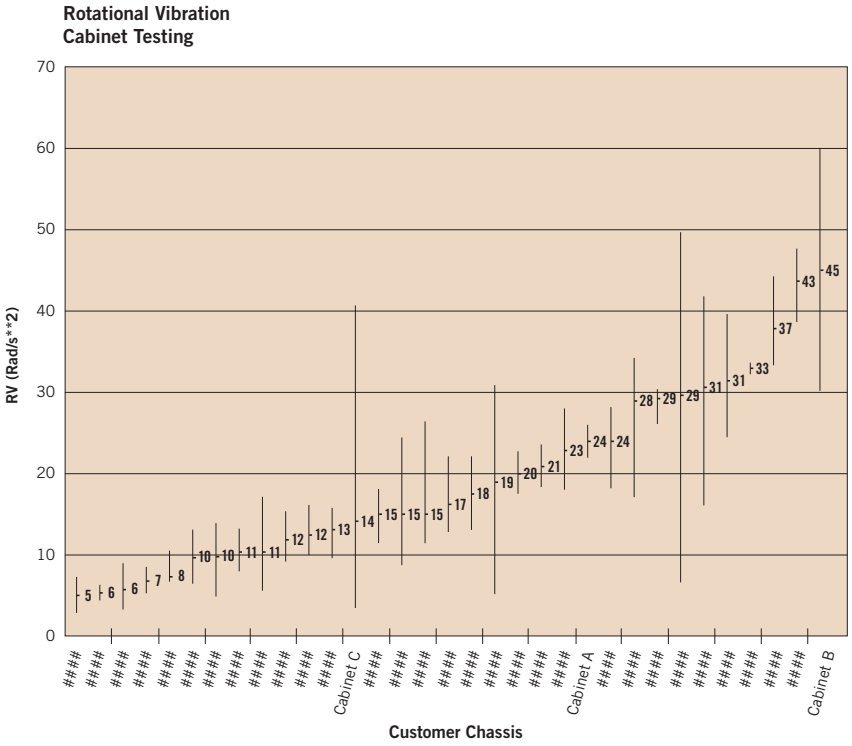
Results:





You can see that both Cheetah and Barracuda drives dominate the field with respect to rotational vibration performance. This is significant!

Cabinets of various sizes and qualities have been tested for their ability (or inability) to minimize the transmission of RV energy through the cabinet and into the drive. The cabinet tests show both slot-to-slot variability within each cabinet as well as the overall ranking of each cabinet in test. Enclosure manufacturers are listed in the graph below from best to worse (L to R), but the names have been removed because of confidentiality concerns.



In summary:

- Rotational Vibration is a dynamic force found inside all multi-drive systems that is detrimental to disc drive performance.
- In-cabinet RV tests show that Seagate drives can maintain a 99 percent performance level while competitor's drives performance falls below 50 percent in the same RV environment.
- Test results taken from single-drive RV test stands show leadership across the board by both the Cheetah and Barracuda.

The bottom line is: Seagate customers with multidrive applications benefit greatly from actually achieving the specified performance levels when drives are mounted in cabinets performing real world applications. The competition's actual performance in multidrive configurations fall far short of the Cheetah and Barracuda.

Continue to look to Seagate for performance leadership.

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