Innovative Design for Storage Enclosures

Density in the Data Center

The constant growth in the need to store, manage and manipulate more data is driving data center capacity. The most efficient data centers are focusing on increased density as a way to manage this growth and still contain costs. There is high density in server deployments with compute nodes packed into smaller form factors to increase the number of servers per rack. Storage shelves are also increasing in density to grow capacity per rack. These dense enclosures full of storage devices are being run with higher workloads than before and need to maintain performance, while operating reliably and keeping costs to a minimum.

Power and Cooling

One of the challenges of very dense storage enclosures is effective cooling. Typically, air is drawn into the box from the cold aisle in the data center. This air passes over successive rows of drives getting warmer with each row and is then expelled out into the hot aisle. The drives closest to the cold aisle are usually cooled effectively while the drives towards the hot aisle are being cooled by warmed air.

Even if they are running within their specified temperature range, disk drives and SSDs (like most devices) are generally more reliable when operating in the lower ranges of the specification.

How ArcticFlow Works

The enclosure is divided into two zones, with rows of drives in the front, and rows of drives in the back. The front zone is cooled conventionally with the air drawn in from the cold aisle, but the warmed air is then ducted around the sides of the rear zone directly to the hot aisle. For the rear zone, cold air is drawn straight from the cold aisle into the center of the box and distributed through the rear drives, and to the exhaust on the hot aisle. This patented Western Digital technology brings innovation to a well-established product segment and delivers significant benefits.

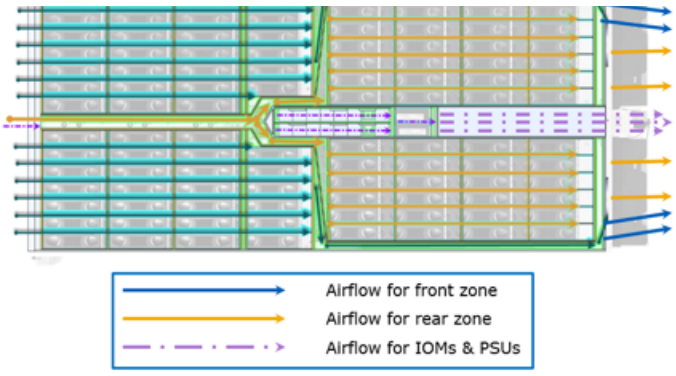

Figure 2. Ultrastar Data102 showing thermal zones and airflow

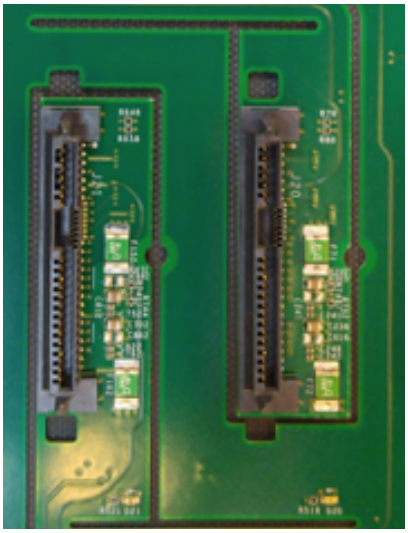

Figure 1. Precise cuts in the baseboard for vibration reduction

Energy Savings

In testing against a competitive enclosure, the Ultrastar® Data102 requires just over half the cooling power per drive slot. To put this in perspective, using California energy costs and typical data center efficiency, the savings amount to $1,500 per enclosure over a typical five-year system lifecycle. In a large data center with 20,000 drives, this could be as much as $300,000 savings in energy costs.

Enhanced Reliability

In testing the Ultrastar Data102 against the competitive enclosure, 30% of the drives in the competitive boxes ran at an average of 13°C hotter than in the Ultrastar Data102. Using an Arrhenius model for reliability de-rating, those drives running at elevated temperatures are 44% more likely to fail. Thus, based on this model the comparable enclosure without ArcticFlow is likely to have 13% more drive failures over its life.

Why Vibration Control Is Important

Today's high capacity disk drives depend on squeezing ever-tighter track density onto the magnetic platters. There are extremely tight tolerances on positioning the read/write head correctly to follow the data track. Despite very sophisticated servo mechanisms in the drives, external shock and vibration can cause the head to take longer to settle onto the track and can even cause the head to go off track. There is almost no danger to the data if this happens as the drive senses the shock and shuts off the write gate or stops reading; but it can cause a performance lag while the head waits for the data to come around again. The effect on the application is a slowdown as additional latency is added to disk operations.

Shock and vibration can be propagated in different ways. External shock, such as sliding a drawer into a data center rack, is easily understood, but in a dense array of disk drives, adjacent drives that are seeking at high speed can induce vibration into their neighbors. Fans create vibration through the chassis and also through the air as sound energy.

The drives manage this vibration in different ways to ensure data integrity. For reads, the head has to resettle and wait for the correct sector to come around again so that reading can continue. For writes, the write gate is shut off so that adjacent tracks are not corrupted. Then the head has to resettle and wait for the correct sector to come around again so that the data can be written in the correct place.

How IsoVibe Works

IsoVibe is a collection of Western Digital patented design innovations. Precise cuts in the baseboard act as a suspension for the drives providing isolation from the vibration transmitted from one drive to another. Vibration-isolated fans also minimize vibration and noise transmission. Additionally, vibration-isolated fans reduce the amount of transmitted interference and acoustic vibration.

Comparison testing in standard environmental conditions against two conventional enclosures showed that IsoVibe reduces rotational vibration of the drives by over 60%. Also, testing against another competitor enclosure showed head positioning total run out (a key measure of how a read/write head stays on track) reduced by 24%.

This management of vibration ensures that the drive heads are less likely to be thrown off track and therefore more likely to maintain desired performance.

The overall benefit is that performance is maintained across the platform, even when all the drives are working hard. Shock and vibration control is a significant factor in our disk drives and also our enclosure products. IsoVibe will allow Western Digital to introduce future products with even tighter track densities and enable them to operate in dense enclosures with minimal performance degradation.

Silicon to Systems Design

Western Digital has deep understanding of the interaction of devices and systems. From silicon and magnetic recording technologies to rack-scale systems, we design, develop and manufacture components that go into our entire portfolio of products, which then gives us the ability to fine tune and optimize everything through to the final product. We call this our Silicon to Systems Design approach and one example of this is that ArcticFlow allows lower fan speeds which also contributes to the benefits of IsoVibe.

ArcticFlow and IsoVibe are included in Ultrastar Data60 and Ultrastar Data102 hybrid storage platforms and also in the Ultrastar Serv60+8 hybrid storage server. For more information please visit www.westerndigital.com.

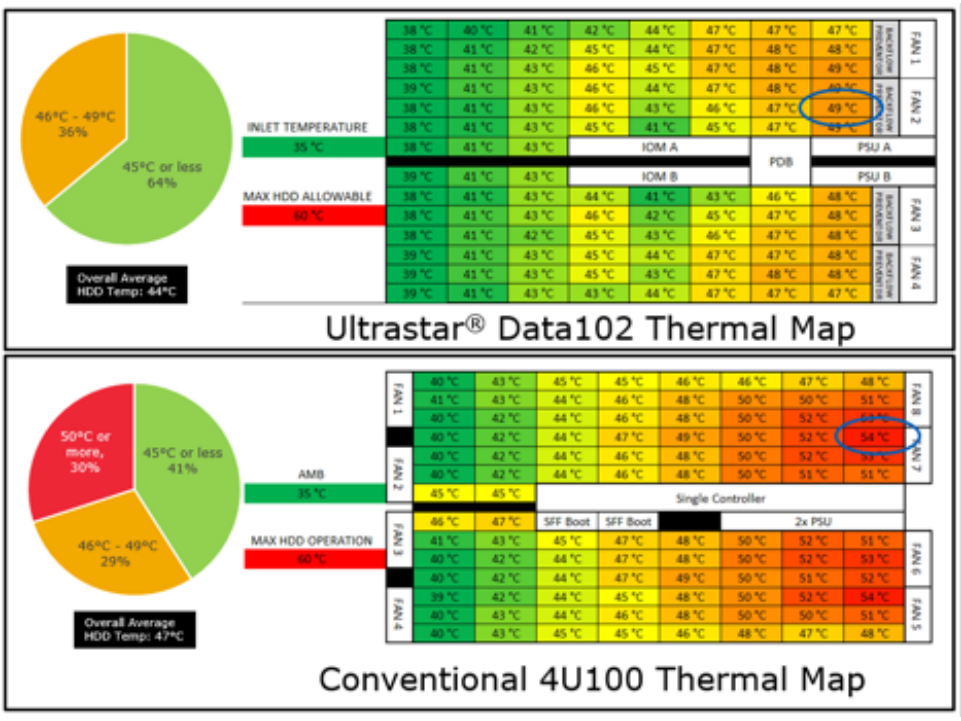

Figure 3. Ultrastar Data102 internal thermal comparison

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