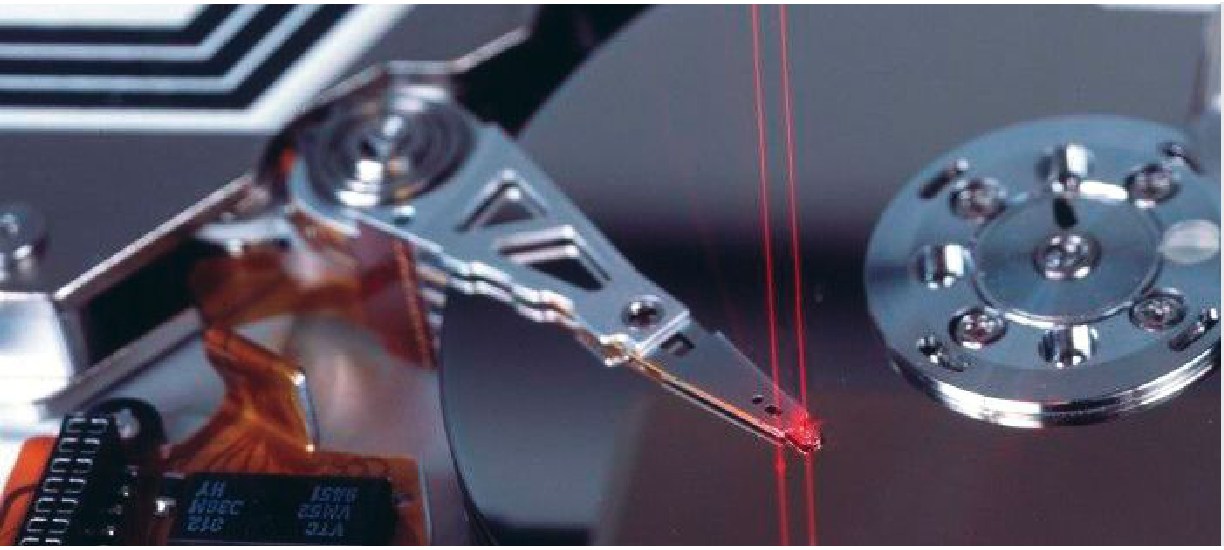
Polytec

Minimize Disturbances by Design



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Optimization of Air Flow in the Read/Write Unit of Hard Disk Drives Using Laser-Doppler Vibrometry

Laser vibrometers are proven and reliable tools for dynamic tests on data storage media such as hard disk drives (HDD) or DVD drives. Inside HDDs, the read/write heads are gliding on a kind of air bearing, which can introduce undesired vibrations to the system under certain conditions. Both Single-point and Scanning Vibrometers from Polytec were used to follow the stable and unstable flying behavior of the heads inside a disk drive via a glass window which had been mounted on the HDD housing.

Introduction

An air bearing design was investigated with respect to air flow induced vibration (FIV) inside hard disk drives. Different HDDs were built with several different air flow designs that produced stable or unstable air bearing flying behavior. This study was used to determine configurations that minimized air flow disturbances around the suspension and integrated lead system (ILS). The maximum amplitude resonance points were investigated at leading and trailing edges (roll and pitch sensitivity) of the head and suspension. Several HDD components, named air blocks, were changed that directly influenced the air flow disturbance around the head/suspension and ILS. Single-point and scanning (2-D) Polytec LDVs were used to follow the stable and unstable flying behavior of the heads inside a HDD via a glass window. Several methods were devised to damp out the most severe vibration levels. Computational fluid dynamics (CFD) modeling was also used to determine the FIV across several features of the suspension system.

Measurements

The front cover of the drive was modified with an optically clear glass plate shown in Figure 1 so a laser beam could be projected onto the top head in the drive.

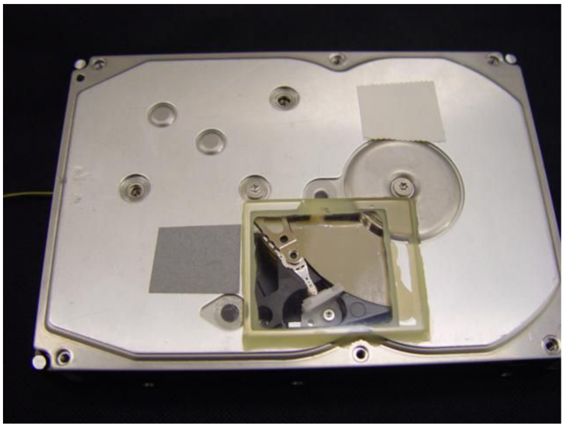

Figure 1: Window in HDD cover.

The drive was placed in a LDV laser microscope system with a laser beam projected through the microscope's optics and then through the drive's front cover via the glass window. The signal was received back again by the reflected beam. A strong resonance signal band of low frequencies was discovered on the trailing edge of the slider with the laser beam reflecting through the suspension and focused onto one of the two trailing edge corners of the head shown in Figure 2.

These modulation signals were established as some of the vibration modes of the ILS and the suspension. It is surmised that the resonance signal propagates from the ILS through the head's bonding pads and directly to the trailing edge of the head. Comparative work has also progressed with a control file with a different airbourne suspensions (ABS) and air flow characteristics to establish whether the same resonance mode signal exists in this file. This article will describe various methods of damping the main resonance modes by changing or removing air flow components while keeping the ABS design the same.

Results and Discussion

Before the LDV measurements were started, the file was subjected to a magnetic testing in which the file was followed by a magnetic signal Wallace equation analysis. The analysis obtained the non-repeatable runout (NRRO) or spectral coherence of the signal. The results are shown in Figure 3 which indicates strong head resonance signals. The LDV measurement correlated with the NRRO data.

It was suspected that new air flow components were causing an undesirable air flow that forced the modulation of the suspension and ILS. The control HDD didn't have these components and didn't have the strong head or ILS resonance problem. The major air flow component was a long air flow block which was situated downstream of the head/suspension/actuator assembly. Identification

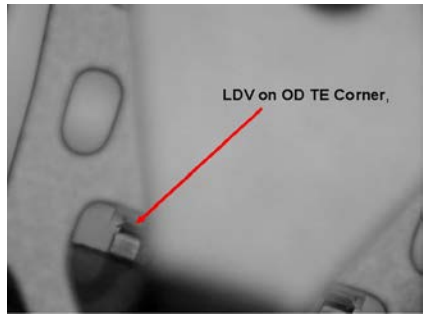

Figure 2: LDV on trailing edge orner (outside diameter).

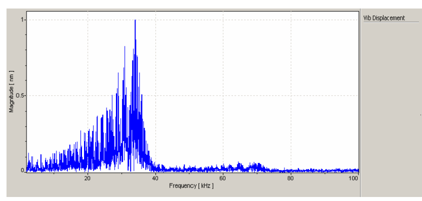

Figure 3: Band of head resonance.

of the block and removing it showed changes to the head resonance band. Figure 4 shows a HDD that has 2 types of air flow blocks with different lengths, short and long.

These were compared to no air flow block. The LDV results of this study with different blocks are shown in Figure 5.

In this plot, a comparison is shown of the head resonance for short and long air flow blocks versus no block. The short block contributed to the maximum head resonance of 1000 pm and the long block attenuated the resonance to 300 pm. For the case of no block the head resonance was observed to be 650 pm. It is hypothesized that the short block caused turbulent air flow to affect the suspension system causing it to oscillate. The long block created a large upstream wake with low turbulence. It is evident from this data that air flow blocks contribute to some degree to changes in head resonance conditions. The size of the blocks can contribute to other air flow effects such as lateral vibrations of the head leading to track mis-registration (TMR).

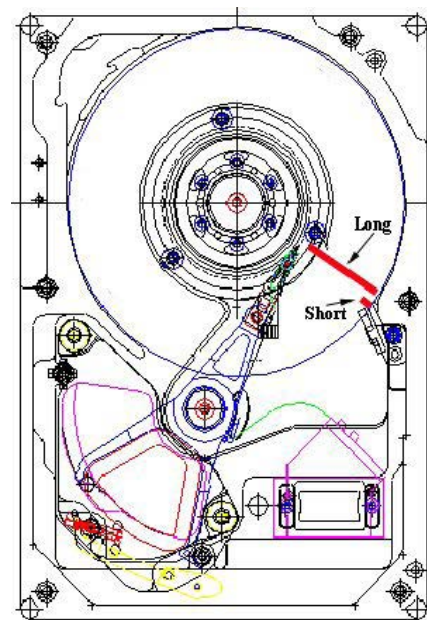

Figure 4: Air blocks short & long.

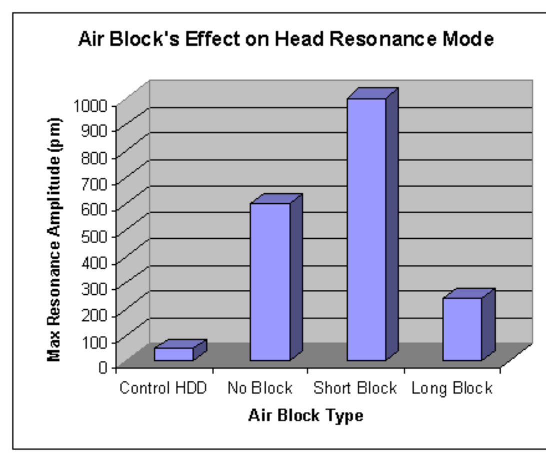

Figure 5: Air-flow block's effect on resonance.

The effect of the air flow on the ILS system has also been modeled with respect to a symmetric portion of the ILS copper traces and polyimide. This analysis has shown that the ILS is sensitive to air flow in the areas around the gimbal portion of the structure. A diagram of the symmetric portion of the ILS is shown in Figure 6.

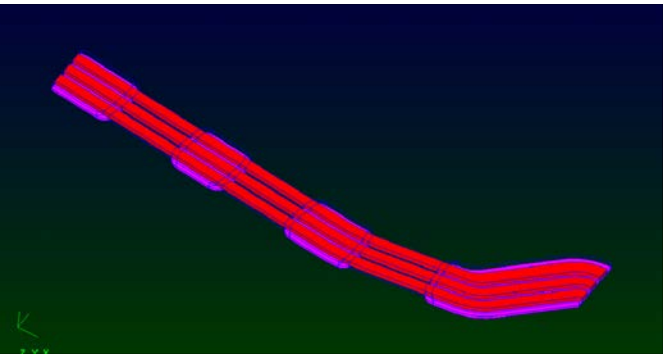

Figure 6: Symmetric ILS polyimide.

Conclusion

Unstable FIV resonance modes were measured with a LDV instrument that showed that the head was susceptible to a band of vibration when the ILS and suspension was perturbed by air flow turbulence. It was determined that HDD air flow components, namely air flow blocks were affecting the air flow around the ILS/suspension system causing the vibration to be transmitted into the head. The CFD analysis included a finite volume model of the ILS polyimide structure that showed vertical excitations by the skewed air flow.

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