Evaluation of a Slider with an Integrated Magnetic Microactuator Using Laser Doppler Vibrometry

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For providing a second stage actuation capability for Hard Disc Drives (HDD), a Slider with an Integrated Microactuator (SLIM) was developed [1]. It is not only capable of lowering the Read/Write element to its (quasi-static) flying height, but more importantly allows its second stage track following. On real systems, the Read/Write element is intended to reside on a chiplet. The chiplet itself is attached to a mounting platform suspended by two leaf springs. A pair of integrated micro electromagnets appropriately energized activates this mounting platform and thus the Read/Write element. The SLIM consists of a micromagnetics and a micromechanics part fabricated on two separate wafers. The evaluation of the electromagnetic microactuator was conducted using Scanning Hall Probe Microscopy (SHPM) measurements [2].

This paper describes an investigation of the dynamic system characteristics using Lased Doppler Vibrometry (LDV) measurements. This approach allowed to determining both the frequency behavior as well as the actuator motion. LDV measurement systems are widely used for a precise measurement of the motion or velocities in magnetic recording systems. The measurements presented here were carried out using an MSV-400 Microscope Scanning Vibrometer from Polytec. For the tests, the vibrometer unit was mounted under an optical microscope.

Of particular interest is the resonance behavior of the microactuator in the translatory mode (flying height variation) and the rotational mode (second stage track following). For evaluating the resonance behavior, the SLIM was subjected to tests in a non-flying state (i.e. suspended on a test fixture and not exercised on a rotating disc). The test systems were completed head assemblies (SLIM devices mounted on a flexure). The SLIM device subjected to the investigations had leaf springs suspending the mounting bar featuring the dimensions of 500 µm x 150 µm x 5 µm (l x w x t), which are the leaf spring dimensions settled upon. For the first set of tests, the mounting platform did not carry a chiplet.

For resonant frequency measurements, the SLIM's microactuator was excited by an RF signal and the resulting vibration was picked up by the LDV measurement system. Due to the fact that the microactuator is intended to be excited with a direct current, no shift in the polarity of the drive current is allowed. Therefore, a zero-to-peak voltage amplitude of 200 mV was used for the excitation. Since each micromagnet has an Ohmic resistance R of 1.6 Ω, the respective zero-to-peak current amplitude is 125 mA.

For achieving a translatory motion of the slider's mounting platform, both of the SLIM's micromagnets were excited in phase. For picking up the resulting vertical displacement, a laser spot was focused on the center of the mounting platform. The motion was detected by conducting the measurements in the out-of-plane mode. On the other hand, a rotational motion was accomplished by exciting only one of the SLIM's two electromagnets. In this case, the LDV measurement system used two laser beams (one in the center of the mounting platform and one at the rim) to establish the rotational motion. During the measurements, the frequency was varied between 0 Hz and 200 kHz. The first harmonic (translatory mode) was detected at a frequency of 1.3 kHz. The second harmonic (first rotational mode) was 5.7 kHz.

Furthermore, the translatory motion of the slider's mounting platform, which is carrying the chiplet (on which the Read/Write element will reside in the real system), was evaluated. For exciting both actuators with a current of 150 mA, a lowering of 2 µm was detected.

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References:

[1] H.H. Gatzen, P.J. Freitas, E. Obermeier, J. Robertson: A slider with an integrated microactuator (SLIM) for second stage actuation in hard disc drives. *IEEE Trans. on Magn.*, Vol. 44, No. 11, pp. 3726–3729, 2008

[2] D. Dinulovic, H. Saalfeld, Z. Celinski, S.B. Field, H.H. Gatzen: Evaluation of an Electromagnetic Microactuator Using Scanning Hall Probe Microscopy Measurements. Journal of Applied Physics, Vol. 105, 07F119-1, 2009

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Short abstract:

For providing a second stage actuation capability for Hard Disc Drives (HDD), a Slider with an Integrated Microactuator (SLIM) was developed [1]. It is not only capable of lowering the Read/Write element to its (quasi-static) flying height, but more importantly allows its second stage track following. For the slider evaluation, LDV (laser Doppler Vibrometry) measurements were conducted. These measurements not only allowed to determining the SLIM's natural frequencies but also to measuring the motion of the slider's mounting platform which is carrying the chiplet with a read/write element.

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