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Design Procedure and Analysis for Ramp Profile in SFF HDD

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Load/unload(L/UL) mechanism has been widely used in small form factor hard disk drive(SFF HDD) because L/UL technology has many advantages necessary for portability. The ramp profile is one of the most dominant parameters which affect L/UL performance. In this paper, we focus on the effects of ramp profile during the unloading process and the design procedure of optimal ramp profile to improve the unloading performance.

Firstly, the effects of vertical unloading velocity are investigated by experiments(Fig.1). Vertical unloading velocity is very important factor to determine the unloading performance, and it is changed by an actuator velocity and the ramp profile. However, in emergency parking, servo system doesn't operate, it is impossible to control the actuator velocity, and then the vertical unloading velocity depends on only the ramp profile. Secondly, the motions of a suspension and a slider are classified three stepssuch as no dimple separation, dimple separation / no limiter engagement and limiter engagement(Fig.2). In each step, the governing equations are derived from relations of various forces and suspension stiffnessin condition of ramp height and length proper to actual SFF HDD. Thirdly, designable ramp slopes in each step are gained from critical unloading velocity that is boundary between the slider-disk contact and none, tolerance ratioto consider that unloading point is changed by disk vibration and the governing equations(Fig.3). Finally, optimal ramp profile is designed and made through the ramp slopes which are calculated on previous process, ramp height and length. As a result of the simulation and experiment, to improve the unloading performance is identified in the velocity over the critical unloading velocity.

Therefore, this paper analyzes the unloading dynamic characteristics forvarious vertical unloading velocities, establishes the thesis for the optimal ramp profile design and verifies the design procedure for the ramp profile in SFF HDD with the experiment.

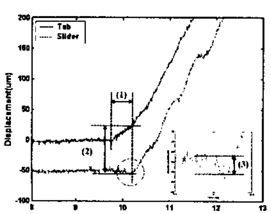

Fig. 1. Effect of unloading velocity

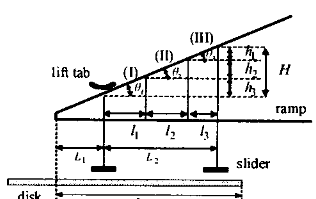

Fig. 2. Schematic for ramp profile

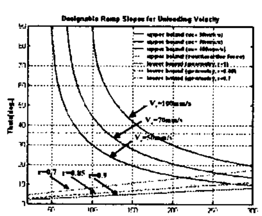

Fig. 3. Designable ramp slope

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Slider Design Optimizations for Enhanced Dynamic Load/Unload Performances

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This paper is to suggest an advanced design optimization of slider air-bearings for load/unload (L/UL) applications using a simplified approximate model instead of using the expensive dynamic L/UL simulations. L/UL technology, which has recently applied tomost disk drives as well as mobile and server disk drives [1], is still sufferingfrom the possibility of slider-disk contact during the dynamic L/UL process. To solve this contact problem, many works have encouraged the slider air-bearing designs using the dynamic L/UL simulations. The issues in simulation based slider designsare not only how to formulate the dynamic L/UL slider design problem but also how to deal with a huge amount of computational time in solving time-dependent dynamic L/UL equations. In this paper, a design optimization problem is formulated to minimize the amplitude of lift-off force during the unloading process while keeping the flying height, pitch and roll angles within suitable ranges over the entire recording band as well as reducing the possible of slider-disk contact in steady state. To reduce the burden of the expensive dynamic L/UL simulations, an approximate lift-off force during the unloading process is generated through data screening process. The FRAMAX [2] is utilizedas a design framework to wrap effectively and connect the analyzers to the optimizer. To evaluate the effectiveness of the proposed design approach, the optimum designs are carried out from both the conventional pico and femto slider models for 1-inch disk drives. Their dynamic L/UL simulation results show that the optimally design sliders had smallerramp forces (by 21% off in pico slider and by 1.2% off in femto slider) as well as smaller lift-off forces (by 62% off in pico slider and by 10% off in femto slider) thanthe initial ones, respectively, while keeping the desired static characteristics over the entire recording band. It is also demonstrated that the designed slider incorporated with the suspension is not only properly unloaded onto the ramp without rebounding problems, but also smoothly loaded onto the rotating disk.

ACKNOWLEDGMENT
This research was supported by the Center of Innovative Design Optimization Technology (iDOT), Korea Science and Engineering Foundation.

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