Possibility for ESD Protection of Recording Heads in Deshunting Process based on Machine Model

Apirat Siritaratiwat, Member and Nuttachai Juthong, Non-member

ABSTRACT

The Machine Model, MM, used in this study is based on that in the standard test method [1]. It is found that the inductance of MM can seriously cause the damage of GMR and Al gap. It is found that a wide time-interval of deshunting or a slow deshunting possibly causes GMR and Al gap damages depending on its Machine Model inductance, L_{mm}. It is also shown the protection possibility by connecting a bypass capacity or, C_{Bypass}, between GMR and Al gap. It is not much obviously seen the useful protection in the GMR but it is undoubtedly in the Al gap. The gap voltage descends from ∼16V to 1V, or less, after connecting a 10 nF C_{Bypass}, or more. The dependence of GMR and Al gap on the added C_{Bypass} is also shown.

Keywords: Electrostatic discharge, Machine model, Recording head

1. INTRODUCTION

The recently serious problem in hard disk drive industry is the electrostatic discharge, ESD, effect because it can damage GMR head and Alumina, Al, gap in recording heads. The cross-sectional model of a GMR head is shown in Fig.1. Now a day, automatic machines are widely used and so, the ESD effect occurred by these machines becomes possible.

A process that possibly causes the ESD is the deshunting process. It has been found that the ESD effect based on human body model, HBM, could possbly destroy the Al gap between GMR head and bottom shield [2]. In addition, a cutting device could also possibly damage GMR head [3]. There are 3 main parameters causing head damages in this process; i.e. time interval of deshunting, deshunting sequence and HBM resistance.

2. EXPERIMENTAL METHOD

In the simulation experiment, firstly, a fully charged 200 pF C_{mm} is discharged and the switch No. 1 is close. The switches No. 3-No. 5 are then promptly open at the same time and finally switch No. 2 is open. The inductance of machine model, L_{mm}, is varied in a range of 0.5 µH - 0.5 H in order to study the effect of L_{mm}. In each value of inductance, the time interval of deshunting and applied voltage are also varied from 0.2 µs to 10 ms for the measurement of voltages across GMR and Al gap; i.e. C_{2} and C_{3}. In practice, voltages drop across GMR head and Al gap of an order of ∼1 V and ∼16.75 V respectively are damageable.

A C_{Bypass} is connected as shown in Fig. 2 in order to study a possibility of ESD protection. It is varied in a range of 0.1 pF - 1 F with a fixed 0.5 µH L_{mm}.

3. SIMULATION RESULTS AND DISCUSSIONS

It is seen in Fig. 3 that, for L_{mm} ≥ 50 µH, V_{GMR} is less than 1 V which means that the GMR head is still not damaged. However, it tends to be damageable as a time interval of deshunting is less than about 60 µs for 0.5 µH and 5 µH inductance.

This is obviously seen in Fig. 4 that, for L_{mm} ≥ 5 mH, V_{Gap} is less than 16.75 V which means that the Al gap is still operational but the rest of them are totally destroyed without consideration of deshunting time-interval. It is found from these contrast results that a narrow interval-time of deshunting or a fast deshunting process can risk the GMR but a wide interval-time of deshunting or a slow deshunting process is dangerous for Al gap.

This can be protected by connecting a C_{Bypass} as shown in Fig. 5 and Fig. 6. It is seen in Fig. 5 that V_{GMR} is lower than the critical value, 1 V, when a 100 nF or 1 µF is connected. It is observed that, for a low capacitance of C_{Bypass} connection, GMR head is still in a risk and dependent on time interval of deshunting. In addition, it is obviously seen in Fig. 6 that for C_{Bypass} ≥ 10 nF, Al gap is still in an operation because V_{Gap} is less than 16.75 V. It is also independent on time interval of deshunting.

4. CONCLUSION

It is found from the results that a low machine model inductance, L_{mm}, can possibly damage GMR heads if a fast deshunting is performed. Although a voltage across Al gap, V_{Gap}, is in danger for all low
L_{mm}, it may be unaffected if a fast deshunting is performed for high L_{mm}. Nevertheless, it begins to be destroyed as a time of deshunting becomes wider or slower. Therefore, the automatic machines possibly damage GMR head or Al gap, but however this can be protected by connecting a suitable C_{B}Bypass. This head will also be independent on deshunting speed.

References


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\[ C_{\text{mm}} = 200 \text{pF} \]

\[ L_{\text{mm}} = 0.5 \mu\text{H} - 0.5 \text{H.} \]

Fig. 2: The Equivalent Circuit for Head Protection

Fig. 3: The Dependence of \( V_{GMR} \) on Time Interval of Deshunting and \( L_{\text{mm}} \) as \( C_{\text{mm}} = 20 \text{pF} \)
Fig. 4: The Dependence $V_{\text{Gap}}$ on a Time Interval of Deshunting and $L_{\text{mm}}$ as $C_{\text{mm}} = 20 \, \text{pF}$

Fig. 5: $V_{\text{GMR}}$ and Interval Time as $C_{\text{Bypass}}$ is connected

Fig. 6: $V_{\text{Gap}}$ and Interval Time as $C_{\text{Bypass}}$ is connected