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A miniature charged plate for testing charge accumulation in hard disk drives ☆

M.A. Noras[a,*], B. Wang[b], V. Nguyen[b]

[a]*Trek, Inc., 11601 Maple Ridge Rd., Medina, NY 14103, USA*
[b]*Samsung Information Systems America, Inc., 75 W Plumeria Drive, San Jose, CA 95134, USA*

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Abstract

A technique for monitoring electrostatic charge accumulation inside a hard disk drive (HDD) is described: a miniature charged plate is built into the top cover of the HDD, connected to a charged plate monitor. Experiments show that the miniature plate technique can be used for detection and measurement of the voltage induced by the charge generated inside the grounded enclosure of a hard drive.

Keywords: MR heads; ESD protection; HDD

1. Introduction

Charging phenomena at the magnetoresistive (MR) head–disk interface have been studied [1–3], because of concerns about a possible electric discharge between a MR head and the surface of the disk. A tool that is most frequently used for this kind of research is an electrometer, utilized in monitoring of the charge buildup on either the disk or the MR head. Another instrument feasible for electrostatic discharge (ESD) hazard detection inside the hard disk drive (HDD) is an electrostatic voltmeter or a fieldmeter [4]. Yet another technique used for measurement of electric charges on the disk was proposed by Feng [5]. The charge on the head–disk interface is measured by applying varying external potential to the head while reading a signal previously written to the disk. In this method, however, the electric charge on the disk may be modified during the measurement due to an external DC voltage applied to the head. The miniature charged plate technique proposed here offers an alternative, less expensive and possibly more robust approach for charge accumulation monitoring. The plate (2 cm × 2 cm) is installed on the top cover of the disk drive—Figs. 1 and 2(a). In this way the voltage due to the electrostatic charge created inside the HDD enclosure can be monitored.

A number of tests was then carried to find out whether a miniature charged plate installed inside a HDD is able to monitor electrical charging. Results were compared with an outcome of experiments conducted with an electrostatic voltmeter (ESVM) mounted in an opening cut out in the HDD top cover (Fig. 2(b)).

2. Test setup

The test setup consisted of:

Ionizer: 321/s (68 ft^3/min) air flow volume.

Standard charged plate: Trek Model 156P-C150×150-R3M, 15 cm × 15 cm charge plate.

Charged-plate monitor (*CPM*): Trek Model 157.

Electrostatic voltmeter (*ESVM*): P1122 voltmeter with a 5100P probe.

HDD: courtesy of Samsung Information Systems America, Inc.

Miniature charged plate: 2 cm × 2 cm charged plate, mounted on the HDD top cover.

The capacitance of the charged plate–HDD assembly can be adjusted to a desired value by changing the value of

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*Corresponding author. Tel.: +1 585 798 3140.
E-mail address: maciej.noras@trekinc.com (M.A. Noras).

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the input capacitor of the CPM. This instrument uses a driven shield technique to neutralize the influence of the physical capacitance of the charged plate. Two different capacitances were used in the experiments: 20 and 1 pF.

Ionizer balance measurements and discharge characteristics were taken and compared for both plates in order to evaluate feasibility of the miniature plate design. During these tests the miniature plate–top cover assembly was removed from the HDD and placed directly under the ionizer. Test results indicated that performance of the miniature device is comparable to that of the standard plate [6]. The miniature charged plate can be successfully used for the ion balance and the discharge time measurements.

The miniature plate assembly was mounted on the HDD. The metal enclosure of the HDD was connected to the earth ground. The plate is placed approximately 4 mm from the surface of the HDD disk. It is important to allow for an adequate warm-up time for the instrumentation (around 30 min) after it is turned on, in order to obtain reliable and repeatable results.

3. Test results

3.1. Measurements at room conditions

The first set of tests was conducted with the charged plate capacitance of 20 pF, using setup presented in Fig. 2(a). Additionally, a standard 15 cm × 15 cm charged plate was used to monitor environment in vicinity of the HDD. Fig. 3(a) presents the voltage offset registered by the charged plate monitor with the HDD power turned off (the disk was not rotating). The results of tests with the HDD on are shown in Fig. 3(b). The relative humidity during the tests was within the range of 35–40%.

Fig. 3 indicates that the miniature plate does not detect any charge accumulation inside the HDD. In order to increase the sensitivity of the measurement, the input capacitance of the charged plate was lowered to 1 pF.

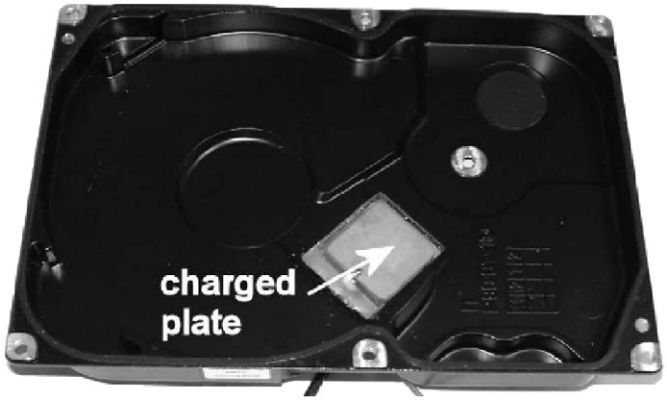

Fig. 1. A miniature charged plate incorporated into the HDD top cover.

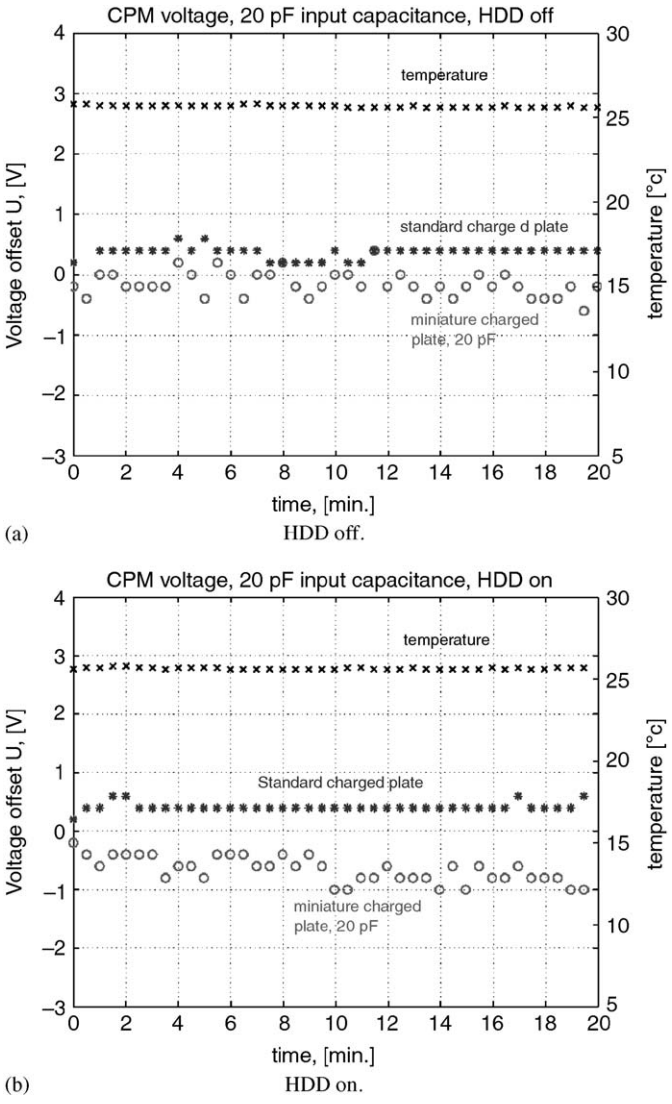

Fig. 3. Voltage offset measured by the charged plate monitor in the closed HDD enclosure, miniature CPM input capacitance 20 pF. (a) HDD off, (b) HDD on.

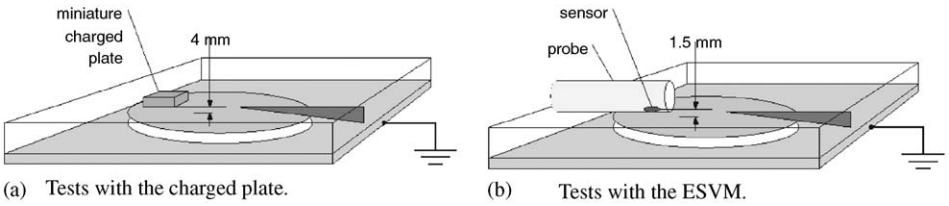

Fig. 2. Test setup. (a) Tests with the charged plate; (b) tests with the ESVM.