Drop Proofing a Hard Disk Drive

HITACHI
Inspire the Next

Dr. William F. Heybruck
Senior Storage Engineer
bill.heybruck@hitachigst.com

Introduction

When was the last time you dropped your desktop PC? When it was running? Never you say? Well the hard disk drive in your desktop PC probably doesn't need drop protection while running. During shipment anything can happen and hard disk drives (HDDs) are designed to withstand the more common shock experienced during shipping. PCs are packaged with that in mind too and since most of today's PCs have a plastic case, they must protect the case as much as the HDD inside.

If I asked the same questions about your laptop, you, like most, probably have dropped your laptop at least once and perhaps even while running. The latest technology laptops today contain a drop sensor that permits the processor to detect a drop and shut down important parts of the machine, specifically the hard disk drive.

Now let's talk about your MP3 player or cell phone. How many times do you drop that device PER WEEK? Again, if you're like most folks, it's not if you dropped it but how many times or how recently. Designing a hand held device, like a PDA, cell phone or MP3 player with a hard disk drive requires designing in some kind of drop protection.

Until now, that protection usually consisted of some foam isolation, and/or some plastic suspension that "gives" when the unit hits a hard surface thus reducing the exterior shock force to a smaller value than is tolerated by the HDD.

Thanks to some new technology from Hitachi Metals, the drop sensor technology that is used in the laptop computers described above, has been reduced in size so that Hitachi Global Storage Technologies (GST) can place that sensor in the new Microdrive® 3K8 as an optional feature called Extra Sensory Protection™ (ESP). This means that the hand held units can now have more storage in a smaller space and still have a high degree of shock tolerance.

How it works

The sensor consists of four piezoresistors that form a full bridge circuit (see figure 1). By monitoring the voltage with a constant current through these resistors, small variations in position can be detected. When the sensor is placed in various orientations, the position can be detected by the changes in resistance value. When the sensor is in a free fall situation, the value of all the resistors are equal since there is no G force in any single direction. This can be detected by an electronic circuit and hence a Zero G sensor is created.

Hitachi Metals has combined a CMOS electronic circuit with this sensor technology in a 3.4mm x 3.7mm x 0.9mm package that permits Hitachi GST to place this package on the PCB of our Microdrive 3K8. By tying the Zero G output to the drive controller, the drive can suspend a read or write operation, and park the head. This can typically occur in a drop of 100mm (4 inches) or more.

The sensor does not have to be in the drive. Devices that implement a drop sensor for their own internal reasons can improve the shock resistance of the HDD by issuing a Standby Immediate command as soon as the Zero G is detected. This would cause the HDD to park the head and enter "non-operating" mode within 140ms (4in) of being dropped. The output of the sensor can then be used to detect tilt in various directions permitting the user to navigate a menu without the use of arrow buttons or a mouse.

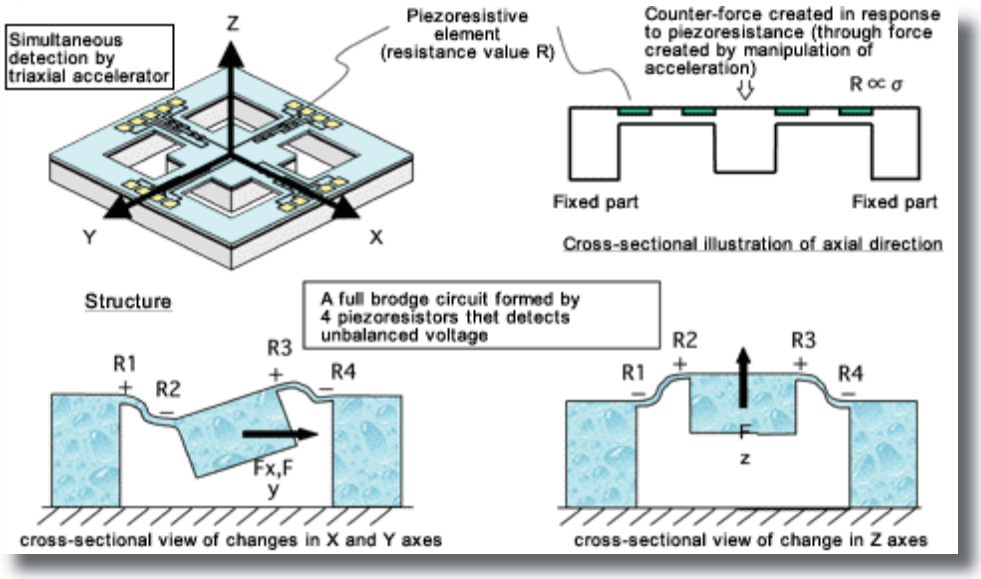

Photo courtesy of Hitachi Metals

Figure 1: Sensor consisting of four piezoresistors that form a full bridge circuit

Hard disk drive implementation

When the disk in a hard disk drive is spinning, there is a layer of air very close to the disk that spins with the disk. As the heads move over the disk, they "fly" on that thin layer like the wing of an airplane. The fly height of the heads over the disk is determined by design of the heads. Figure 2 illustrates the relative distance of the heads to the disk. Similar to designing an airplane to be stable in rough air, the design of the heads can be tweaked to survive bumps and vibrations. Hitachi GST engineers made changes to the head design to improve the shock and vibration performance of the new Microdrive 3K8. This is all in addition to the automatic write termination and read retry feature of the Microdrive microcode that senses when the heads are off track (due to shock or vibration). This technology immediately suspends a write operation (to prevent off track writes) and retries reads where the data may be inaccurate due to off track movement of the heads as sensed by the servo mechanism controlling the arm.

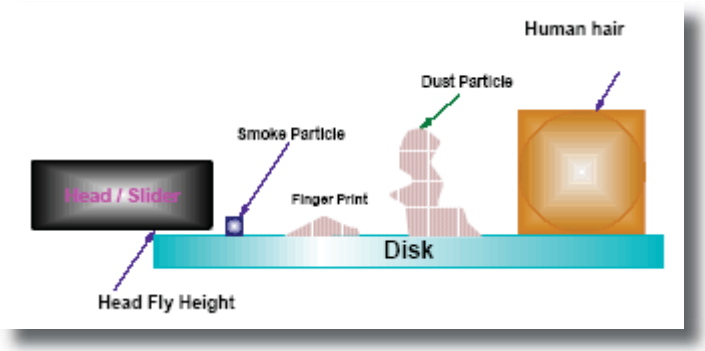

Figure 2: Relative distance of the heads to the disk.

Package design to survive a drop

In addition to those techniques described above, design engineers can use other tools to improve the survivability of a HDD in a Consumer Electronics (CE) device during a drop with or without the additional cost of the Zero G sensor or for those products that wish to implement a similar sensor for their own operation. The most common technique is to use foam bumpers around the drive to isolate the drive itself from the surrounding support. As the device hits the hard surface, the drive is permitted to move as the foam collapses. Thereby reducing the actual shock the drive received by up to 50% of that the device incurs. Another technique is to permit the package itself to break or deform making it sacrificial to save the contents. This technique is not very common since it requires the product to be repaired to restore the appearance. Combinations of these techniques are most often implemented. By suspending the mounting positions of the HDD on plastic springs and using foam bumpers, higher values of shock can be experienced by the device and cause no harm or data loss.

Hitachi GST realized this, and for the new Microdrive 3K8 has designed two bumper solutions. One permits the Microdrive 3K8 to fit in the CompactFlash Type II footprint, but with much higher shock tolerance (Figure 3). The other is a corner bumper solution that improves the operating shock tolerance by 100% over the bare drive (Figure 4).

Figure 3. Microdrive with bumper solution

Figure 4. Microdrive with corner bumper solution

Summary

Designing CE devices with HDDs that can handle drops is now simpler than ever. Hitachi has the technology, products and services to permit your device to have up to 8GB of storage in a robust, reliable and cost effective package.

Hitachi Global Storage Technologies
3403 Yerba Buena Road
San Jose, CA 95135 USA

Produced in the United States 11/07.