**HOW DO SOLID-STATE DRIVES WORK?**

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Solid-state drives are the newest type of hard drives in computers. Solid-state drives are used to quickly save computer information. The article that follows describes the history of a solid-state drive, what a solid-state drive is, how a solid-state drive saves information, and how a solid-state drive performs.

**What is the History of Hard Drives?**

The history of hard drives started with IBM shipping the first *hard disk drive* (a hard drive that uses magnetic disks) in 1956 and continues through today with the newest hard drive, solid-state drive. The first hard disk drive (HDD) shipped by IBM, used 50 magnetic disk to store 5 megabytes of information and took up more room than two refrigerators. The cost was $50,000 ($441,277 in 2016 dollars).

Since then, hard drives have become smaller, while storing more information, at a cheaper price. A new kind of hard drive has arrived, known as a solid-state drive (shown in Figure 1) that use chips to store information.



Figure 1. Solid-state Drive

The standard solid-state drive is 2.5 by 3.5 inches.

**How Does a Solid-state Drive Save Information?**

A solid-state drive (SSD) saves information on flash memory by using gates to control the flow of electricity, in a process that limits the number of times the information can be resaved.

SSDs save information on flash memory. Flash memory may sound familiar. Flash memory is used in thumb drives, which officially are called USB flash drives. Thumb drives use the same flash technology as SSDs and can be thought of as the predecessors of today's SSDs.

SSDs flash memory saves information by using gates, that are arranged in a grid of column and rows, to control the flow of an electric current. At each intersection of a column and a row, two gates form a SSD cell (shown in figure 2). One of the gates in the SSD cell is known as a control gate. The control gate is separated by an insulator to the other gate known as a floating gate. All of this is sitting on a silicon substrate that holds the grid of SSD cells.

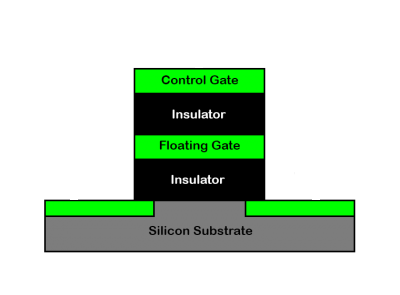


Figure 2. SSD Cell

The standard structure of a SSD cell.

The gates of a SSD cell saves information using a process that controls if electricity is able to flow though the control gate. When an electric current is applied to a control gate, electrons flow onto the floating gate, creating a net positive charge that stops the flow of electricity. If a SSD cell has a flow of electricity, it has the value of 1. If it does not allow a flow of electricity, it has a value is 0. By applying a precise amount of electricity to the gates, a unique pattern of 1s and 0s emerges on the grid of SSD cells.

The SSD cells can only be used for a limited number of times to save information. Each time a SSD cell goes through the erase process, some charge is left in the floating-gate. As the amount of charge left behind builds up, the amount of electricity required to change the gate increases. Eventually, the gate cannot be changed at all, making it impossible to save new information. This process, of saving information, does not affect the read capabilities of a SSD because reading only requires checking, not changing, the electrical state of SSD cells. As a result, SSD cells can "rot" into a read-only state.

**How do Solid-state Drives Perform?**

Solid-state drives perform more reliably, using less power, while accessing information at a higher speed than HDDs.

Because they have no moving parts, SSDs perform with more reliability than HDDs even taking into account the limited times a SSD can save information. With no moving parts, SSDs are also super quiet with none of the whirring and clicking of HDDs.

SSDs use less power than traditional hard drives, which allows batteries to perform longer and stay cooler.

The speed performance of SSDs is better than HDDs. With no moving heads and spinning platters, SSDs can access stored information quicker. The speed of the device manifests itself in many key computer tasks, from booting up system software and opening files, to reading and writing information that even casual users can notice.

Solid-state drives, the newest form of hard drive saves information using flash memory; this results in higher performance and reliability for their users. This increase in performance and reliability can impact many computer users. Game designers, animators, and other power users that generate a large amount of output can have a significant increase in the performance of their computers that can affect their productivity when switching over to SSDs. Gamers, photographers, and even casual users, can appreciate the boost in speed and reliability a solid-state drive delivers.

References

William Harris "How Solid-state Drives Work" 11 September 2012.

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