The Stability and Reliability of Storage Devices

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Stability and reliability are always the top priority considerations for storage devices in industrial computers. Stability Speed is very important too, so how to maintain and optimize reliability has become the focus for manufacturers, suppliers and customers. As a result, NAND Flash technology plays a critical role in storage media such as CF cards, Flash modules, and SSD storage memory.

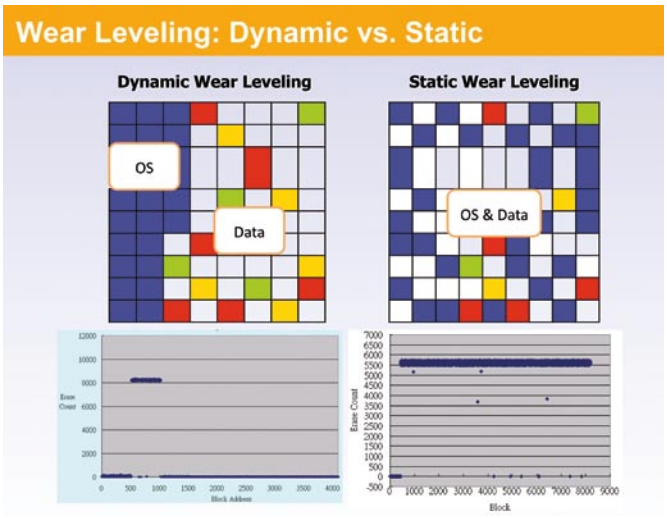
The evolution of the NAND Flash process has already exceeded the estimation of most of people. Three years ago, the manufacturing process migrated from 90nm to 70nm. In 2008, it transferred from the 60nm to 50nm, and 40nm node became the mainstream technology last year. The competition is hotting up in the NAND flash memory market and some vendors have claimed they are using 30nm NAND Flash technology and even pushed toward 20nm.

With process advances, NAND Flash can support the development of more cost-competitive solutions but the reliability of NAND Flash is getting worse. In terms of market response, customers won't just accept inferior quality products because of the price drop. On the contrary, they demand products at the same level but with the same or better reliability and performance. Therefore, the focus of attention has turned to the Flash controller to address this problem.

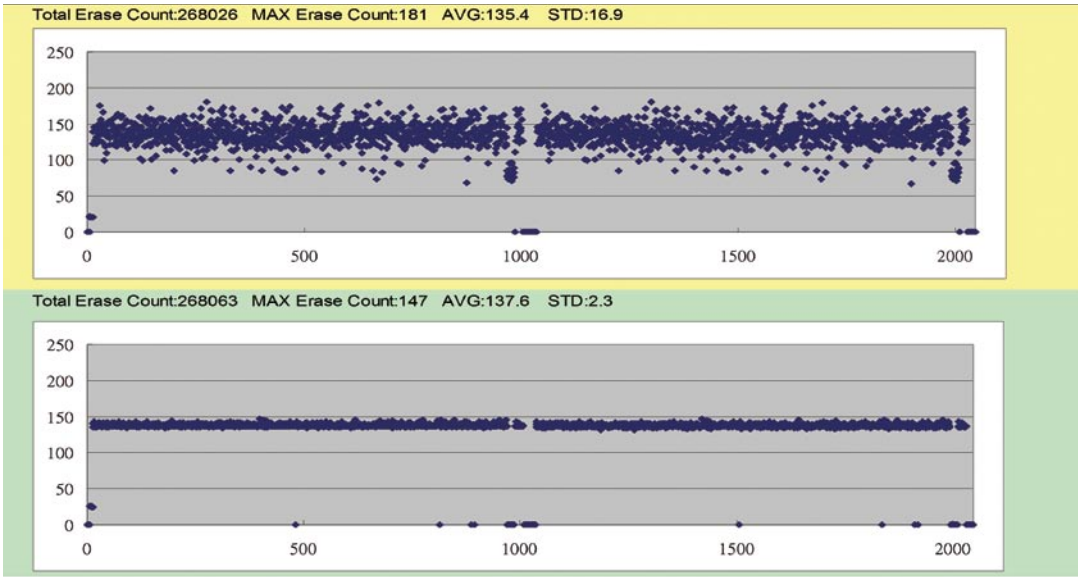
Basically, significant problems of reliability are caused by things like replacing MLC to SLC, increasing 2 bits/cell to 3 bits/cell, reducing the Erase Cycle number from 100K down to 10K, and cutting Data Retention times through the advances of NAND Flash. These issues can be solved within a re-designed and robust controller.

For example, the error rates of NAND Flash are increasing through the new manufacturing process. The controller has to constantly develop better ECC (Error Correction Code) methods and Read Disturbance Management to overcome the defects of NAND Flash. At present, both Reed-Solomon and BCH algorithms are common ECC choices for NAND Flash but BCH is still the most widely used. The quality of ECC can directly affect the reliability of storage media. Comparing three different types of ECC (12-bit/512B, 24-bit/1KB and 48-bit/2KB), they are no obvious differences. In fact, the 48-bit/2KB is superior to the others where many errors suddenly occurred. PHISON Electronics can offer an advanced SSD controller with 48-bit/2KB ECC which is recognized as the most effective ECC solution that can improve product reliability.

In addition, decreasing the Erase Count has brought about a shorter life expectancy of NAND Flash. The wear leveling mechanism of the controller can resolve this problem. NAND Flash consists of many blocks and each block has its certain life span. The number of erasable cycles represented the block life-expectancy and was called the Erase Count. In order to extend the lifetime of NAND Flash, we have to balance the Erase Count of all blocks. With a wear leveling mechanism implemented, the controller can achieve this goal to average the Erase Count of each block.



The following diagrams show the benefits of wear leveling. The abscissa of two charts represents the total number of blocks in NAND Flash and the ordinate is the number of Erase Counts in each block after long-time burn-in testing. The upper chart shows the consequence without the wear leveling mechanism. The Erase Count of each block has been distributed unevenly. However the Erase Count in the next chart is more average, or uniform because of the wear leveling method, and as a result, it can greatly increase the lifetime of NAND Flash.



Of course bad blocks will be generated after using NAND Flash for a while. Therefore, Bad Block Management is very important to ensure that the controller can be replaced in time so that the product can continue to operate. A good controller can not only increase the reliability of NAND Flash, but also enhance information privacy and security through hardware encryption, such as AES (Advanced Encryption Standard). There are a variety of methods to increase product performance in speed, such as multi-channels, interleaving etc. It all depends on the development capability of the controller.

Which kinds of NAND Flash memory are suitable for industrial computers? We can divide the choice into three different types of interfaces. First of all, whether mainframe or desktop platform, the various storage media interfaces in PCs are mainstream. Traditionally, PATA which is also called IDE has been widely used. However the speed of PATA has been lacking recently. In general, there are three options to substitute.

The first option is PCI-Express. From the point of view of performance, the first generation of PCIe had a raw bandwidth of 2.5 Gbps and the second gen was 5Gbps. There are a diverse range of expansion cards for PCIe in desktop computers but for Notebooks, the external storage ExpressCard failed due to lack of universality, and the controller developers lost their interest in PCIe.

The second interface is SATA which is the most commonly used storage interface in the consumer market. In relation to PATA, SATA has the advantage of high speed data transfer rates of up to 1.5 Gbps, SATA II 3.0 Gbps, and the upcoming SATA III 6.0 Gbps. For this reason, the market has been flooded with SATA SSD, and SATA will still be the mainstream choice in SSD interface over the next few years.

The third option is USB which is a very popular storage interface. USB 3.0 has a transfer rate of up to 5.0 Gbps but USB 3.0 devices have not been launched yet, and the products currently on the market are a hybrid solution through the use of a “Bridge Chip”. For storage media in handheld products (such as multimedia players, GPS trackers, or smart phones to name a few), the most important considerations are size and low power consumption rather than speed. However, reliability is still the first priority. Many of these products have widely adopted eMMC as their storage media and many global mobile operators introduced their handheld products with eMMC as the main embedded storage solution. Most eMMC controllers for these products are supplied by PHISON Electronics.

For NAND Flash storage media in industrial computers, the most important issue should be reliability rather than performance. After all, the characteristics of NAND Flash memory are different from that of hard disks. If you can not protect data integrity, they should not be used, even if SSD is much faster. Unlike memory sticks, SSD not only store the OS but also contain data, so if something goes wrong, it could be catastrophic.

When designing controllers, PHISON Electronics always keep reliability as the first priority. We may be able to sacrifice a little performance sometimes, but we never compromise on reliability. NAND Flash controllers play a crucial role in enhancing reliability. A good controller can not only greatly improve a product’s life, it can also provide added value. In order to find the best NAND Flash products, it is very important to carefully choose the controller vendor, that’s why most businesses choose PHISON Electronics.

PHISON Knows What You Need