Removable NAND Storage in Industrial Applications

Reliability Concerns and Risk Aversion Tactics

Samina Subedar
Marketing Manager
ATP Electronics

Removable NAND flash is widely used as digital data storage in both consumer and industrial applications, and SD memory cards as well as SSDs (Solid State Drives) are reliable, high performing form factors. Industrial applications include healthcare, automotive, transportation, and telecommunications where durability and data integrity become crucial in adverse environments. Given the wide usage of removable NAND storage, reliability concerns need to be well understood and the risk aversion tactics must be examined to maximize the ROI of each application.

Challenges

Most SD memory cards are used in consumer electronics, mobile and digital imaging markets. Products are sold through the retail channel and typically use MLC/TLC technology with inferior endurance, reliability, and sample life. The retail channel is mainly driven by cost, inventory turn, and volume. In this channel scenario, product and supply chain management strategies place little or no importance on BOM control/longevity planning and the basic requirements of industrial applications. Conversely, in industrial applications, wide operating

temperature ranges, BOM control, endurance, and sample life are critical features needed for successful implementations and durability. NAND industry trends reflect the importance of SLC industrial requirements through increased longevity and quality with longer transition times between die revisions. Recently, “specialty” MLC (eMLC) products introduced by NAND suppliers focus on extended endurance for enterprise applications. However, these eMLC products can only sustain commercial temperatures ranges (0°C to +70°C) and are not suitable for industrial applications with wide operating range requirements (-40°C to +85°C).

Supply Chain Risk Aversion Tactics

Controlled BOM, Die Changes

Several factors must be examined in order to mitigate the risks associated with the supply chain. A controlled Bill of Materials (BOM) is a critical requirement needed for industrial applications. BOM control ensures that the NAND product is controlled to the controller firmware and the firmware setting level. A variation in the firmware level risks controller operations of NAND flash management and thus affects reliability. Furthermore, a controlled ATP BOM provides long product life cycles with buffer inventory support and advance end of line notices.

Given that the NAND industry is dynamic, regular forward-looking roadmaps and BOM plan updates are required from the NAND product supplier. Updated roadmaps become critical during the qualification process of the product

since they are very likely to change due to market influences and process yield/maturity from the initial qualification.

Another risk aversion tactic to consider is NAND die change. Although die shrinks are of benefit for the end user with decreased use of power, space, and cost, the reliability of the NAND flash can decrease (Figure -1-1).

FIGURE 1-1 Reliability and Die Change

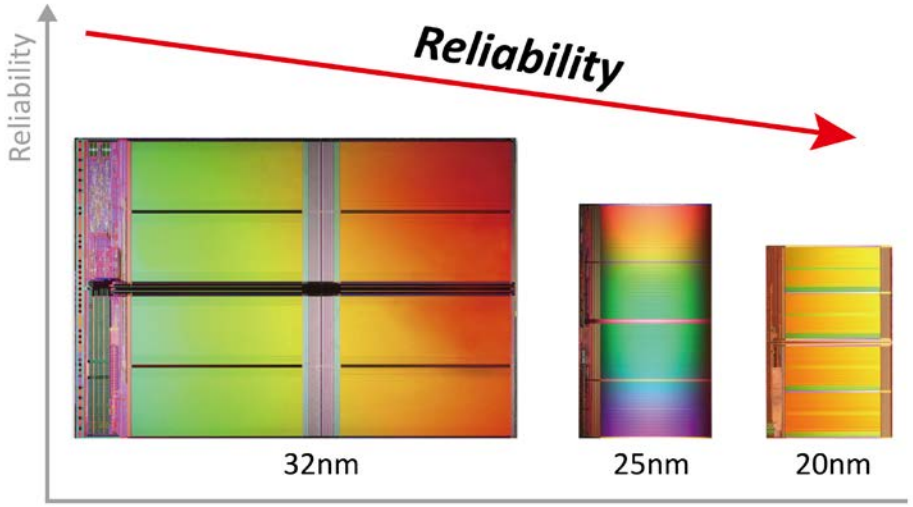


Figure 1-1 illustrates the change from the 34 nm (nanometer) architecture to subsequent 25 nm and 20 nm designs, which have decreased the reliability of flash devices. Given this trend, it is imperative to work closely with NAND product suppliers to determine how changes to architecture can impact the long-term usage model. Attention to this area is key to smooth qualifications and thus smooth transitions in supply chain.

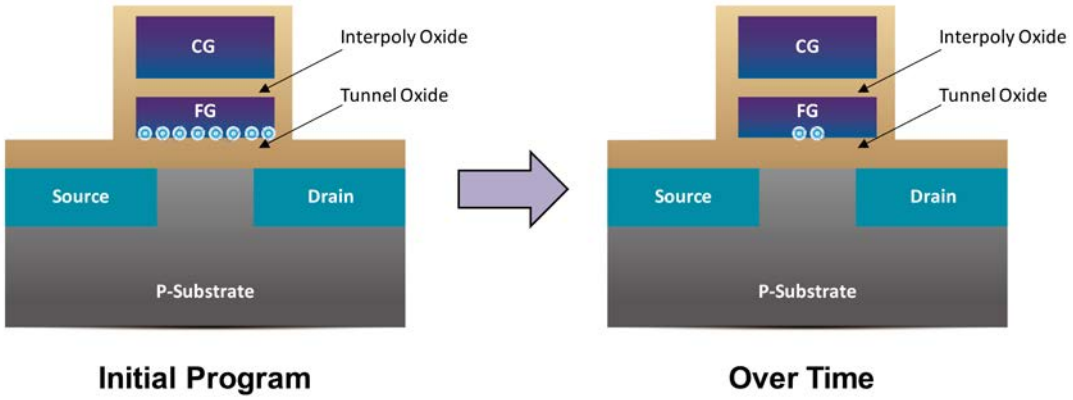
Reliability Concerns and Risk Aversion Tactics

Read Disturb, Data Retention

Read disturb causes data corruption due to accumulated 100K read cycles of MLC or 1M read cycles of SLC on the same page without a rewrite of those cells. Over time, uncorrectable ECC (Error Correcting Code) errors may occur with data loss. This error is very common in read-only applications without regular wear-leveled write operations. In order to circumvent this error, the NAND flash product controller must utilize read disturb detection and avoidance technologies which automatically refresh the NAND before data corruption occurs. ATP NAND flash products execute Static Data Refresh and Auto Refresh technologies to nullify these read disturb concerns. With ATP Static Data Refresh technology, the controller actively monitors the ECC and refreshes the data once a certain threshold is exceeded. With ATP Auto Refresh, the controller automatically refreshes a portion of data blocks during power on. Furthermore, a percentage of write operations can be implemented into the host device usage model for additional risk aversion.

Data retention also causes reliability concerns in NAND flash. Inevitably, charge loss occurs over time in the flash memory cell (Figure1-2).

Figure 1-2 Charge Loss in a Flash Cell



Initial Program **Over Time**

As illustrated in figure 1-2, NAND flash storage is comprised of a small building unit, a “cell”, which consists of a single transistor, “control gate” (CG), and lastly a “floating gate” (FG), to store electrons. A strong voltage field is formed by the voltage difference between the drain and the source. The strong electric field enables the electrons to flow between the source and the drain of the cell, made of semi-conductor materials. A large voltage is applied to the control gate, which creates another electric field and causes a proportion of electrons to be stored in the floating gate. Over time, the number of electrons will decrease in the floating gate, causing a charge loss and consequently, data corruption/ data loss. To decrease the incidence of charge loss, a four-prong strategy can be applied for risk aversion. First, a percentage of write operations should be implemented into the host device usage model given that the pre-condition of write/erase cycles is inversely proportional to data retention. Second, an auto power on algorithm should be implemented into the host device to the SD card for controller ECC handling. Also, the susceptibility of corruption due to data retention of the NAND IC utilized should be quantified, including the variance over temperature and in

some cases, NAND pre-conditioning. Lastly, the incidence of charge loss can be reduced by avoiding prolonged storage of the flash device at higher ambient temperatures.

ATP fully understands the challenges and risks associated with removable NAND flash storage for industrial use and focuses on mission critical applications. With these risks in mind, ATP employs a full range of risk aversion tactics based on each application usage model to ensure an optimal total cost of ownership.

About ATP

ATP Electronics is a leading manufacturer of high performance, high quality and durable NAND flash memory solutions and DRAM memory modules. With over twenty years of experience in service based memory products, ATP continues to focus on mission critical applications where high levels of technical support, performance consistency and wide operating temperature ranges are required. ATP offers unique flash technologies such as Power Protector, Secure Erase, and the Elevated Temperature Burn In Testing system to screen for SMT related assembly issues and IC infant mortality. ATP also offers extensive supply chain support with controlled/fixed BOMs and long product life cycles, with components sourced from the Micron's Product Longevity Program with a guaranteed life cycle of up to ten years.

www.atpinc.com

sales@atpinc.com

ATP USA: (408) 732-5000