ProMik Margin Verify

Introduction

Electronic manufacturers, in particular manufacturers producing for the Automotive or Medical Industry or any mission-critical application needs to have certainty that the semiconductors used in the application will function correctly and will keep the data over the specified data retention time. If mission-critical applications fail, it can cost huge sums of money, reputation, or even lives.

The later you find marginally programmed devices in the chain the more money it cost you. Field failures are particularly costly and companies invest significant amounts of money to find failures or potential failure early in the chain. The old rule still applies – the cost of quality is lowest if managed at the device level, more costly at the board or product level, and most expensive when the product is in the field.

Overall Programming Quality

Using top-rated programming equipment ensures the best possible programming. Semiconductor device manufacturers invest billions in new flash processes to improve the yield and millions in test equipment to select the good devices so that the end customer receives reliable semiconductors. However, this effort is not enough. Even if manufacturers of programmable devices ship very reliable products, there are still factors during the actual programming of the semiconductor which can impact the reliability, quality and in particular the data retention of the device.

Certain factors during device programming such as V_{dd} drop, influences by the charge pump, transfer resistance inside the bed-of-needles, deficient contacting or reset trigger caused by the watchdog can cause marginally programmed devices which will ultimately fail in the field. To prevent malfunctions due to marginally programmed cells or data losses, semiconductor manufacturers developed the margin verification concept. ProMik was the first company to implement Margin Verify.

Margin Verify

Margin Verify has only one purpose: To ensure that the charge in each cell is at a proper level and not near the margin. Once verified that the correct charge is at the correct level in each cell, the electronic manufacturer knows that the product will work properly over the specified data retention time period.

In our example a fully erased cell equals the value "1", charged cell equals the value "0". It is recommended to always erase the device before programming to get to a known, defined stage.

If the cell has been erased to a "1" value, the device should internally measure the current level as shown. If the cell has been programmed to a "0" value the device should internally measure a current level in the color as shown. Sometimes the current measured in a cell does not fall perfectly into the "1" region or the "0" region. Instead, it falls somewhere in between and the device will read it either at a "0" or at a "1". Thus the purpose of the cell margin verification is to eliminate false positives and false negatives.
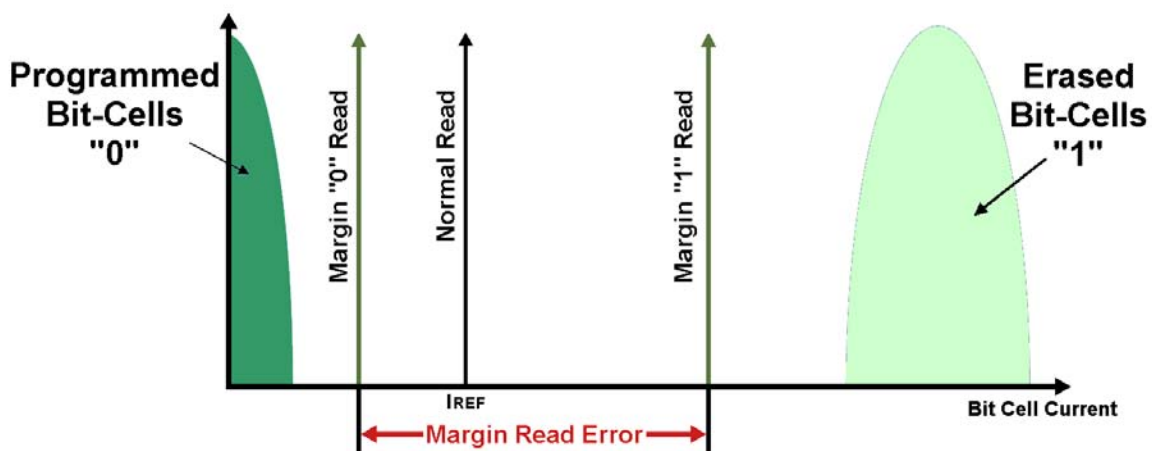
The Verify in normal read mode performed after programming does not catch this failure. This Verify is at the data level and compares the data content of programming file with the data content of the memory space of the device but does not test the quality of the programming.

With ProMik's Margin Verify the device essentially moves the threshold to decide whether a cell is a "0" or a "1" closer to the ideal region. This usually involves a two-step process. First step, the device will move the compare level closer to the "0" region, then anything with current above the new threshold level will be considered a "1". Anything below it will be considered a "0". In the next step the devices moves the threshold closer to the "1" region and the process is repeated.

Summary

ProMik's cell margin verification fully tests the quality of programming to ensure maximum data retention. ProMik's Programming Service programs every year millions of parts has demonstrated a 0 PPM failure rate. Automotive companies or any mission-critical application should always ask for the Margin Verify to ensure perfect data retention for their application. And they should always choose a programming company that provides the best possible Margin Verify. This feature will reduce product failures resulting from component failure and from improper programming.