Ensuring Data Retention for Mission-Critical Microcontroller Applications

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by
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Introduction

In the context of electronic product manufacturing, mission-critical applications are those that are vital to the functioning of an overall system. If the application fails, there are typically undesirable results which might jeopardize human lives or may cause significant damage or loss. Examples of these applications are the brake or air bag system in your car, the chip inside a heart monitoring system, or the chip inside the circuitry that controls the navigation system of an airplane. Even though these are dramatic examples of mission-critical applications, our daily lives are full of similar applications with very low to no tolerance for failure.

Semiconductor device manufacturers spend billions of dollars every year to separate the bad chip from the good chip so that end customers receive reliable products. Nevertheless, this effort is not enough. Even if manufacturers of programmable devices ship very reliable products, there are still factors that may impact the functioning of a semiconductor device during final product manufacturing. One of these is programming. Certain factors such as voltage, frequency and environmental conditions may impact the quality of programming during manufacturing which may cause early failure of a device and ultimately, a system in the field. As is widely known, failures in the field are very costly and their impact on company, profitability and reputation may be drastic.

To prevent data loss or change in device memory and ensure data retention, certain device manufacturers have introduced the cell margin verification concept, including Freescale, NEC, Texas Instruments and Infineon.

As a part of its quality concept, Data I/O supports the concept and implements cell margin verification on its programming platforms to ensure quality of programming and data retention.

Cell Margin Verification

While cell margin verification is called by different names by each manufacturer, cell margin verification has the same purpose across all microcontroller product families: to ensure that charge in each bit is at a proper level, and not near the margin.

Inside each memory cell of a flash device, charge is stored. If the memory cell has been programmed or erased to a “1” value, the device should internally measure a current level in the blue region of Figure 1. If the memory has been programmed to a “0” value, the device should internally measure a current level in the green region of Figure 1.

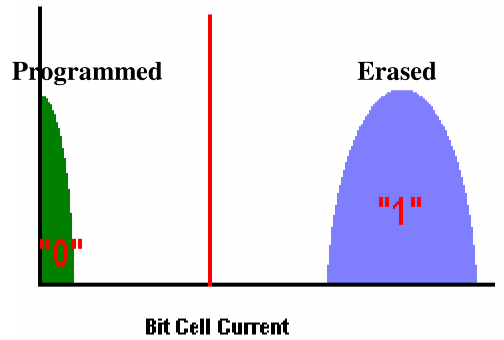

Figure 1. Cell Current Distribution of an Erased or Programmed Location

In reality, 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 needs to make a choice whether to classify that bit as a “1” or a “0”. In most devices, anything that falls to the right of the red line in Figure 2 would be classified a “1” and anything that falls to the left of the red line in Figure 2 would be classified as a “0”.

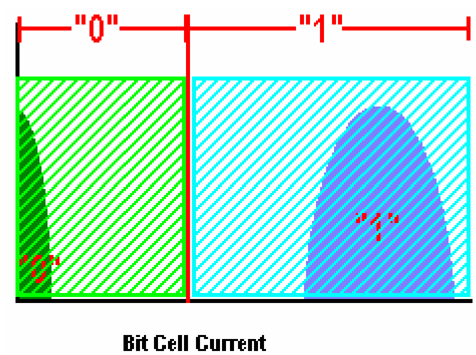

Figure 2. Real-Life Programming Experience

With margin verify, the device essentially moves the sense level that decides whether a cell is a “0” or a “1” closer to the ideal regions. This usually involves a two-step process. In one step, the device will move the compare level closer to the “0” region. Then, anything with current above the new sense level will be considered a “1”; anything below it will be considered a “0”. This is shown in Figure 3. In the next step, the device moves the sense level closer to the “1” region and the process is repeated, as shown in Figure 4.

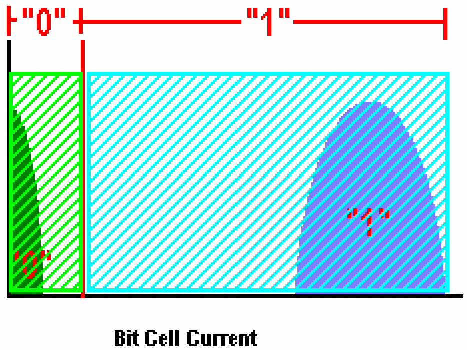

Figure 3. Testing for Under-Programmed Cells

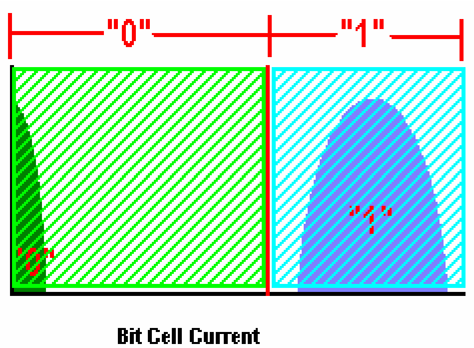

Figure 4. Testing for Under-Erased Cells

As a result of the two passes, bits that are in an indeterminate state will show up as errors as shown in Figure 5, and the customer can have more confidence in the quality of the programming results.

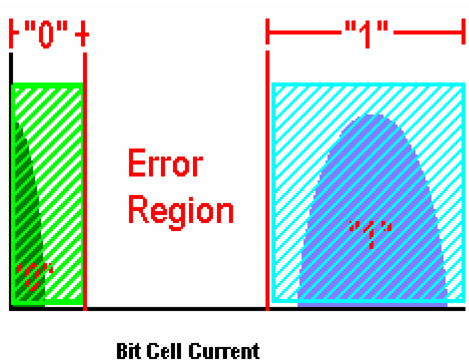

Figure 5. Defining an Error Region

Assuming that devices pass the cell margin verification test, manufacturers of these devices guarantee typically 10-20 years of data retention in their products.

Conclusion

Cell margin verification is essential to verify that devices for mission critical applications are programmed according to manufacturers' specifications and will retain their data as specified.

OEM companies should ask for this feature from semiconductor device manufacturers to ensure data retention and integrity for their applications. This feature will reduce product failures resulting from component failures. The cell margin verification also increases the quality of programming.

Data I/O supports and performs cell margin verification in its algorithms and programming platforms as a part of its overall quality concept. In addition, device failures are recorded in programmer log files, providing quality teams more information about the nature of device failures during programming.

To learn more about Cell Margin Verification and seek recommendation on devices that support this feature, please contact Data I/O Corporation at support@dataio.com or +1-425-881-6444.