Apacer

SmartRead Refresh™

White Paper

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1. Introduction

Due to the way NAND flash memory is constructed, there's always a small chance that error bits may occur during read operations. These are known as 'read disturb' errors, and can be more or less common depending on the architecture of the NAND Flash memory type being employed. In most drive operations, ECC technology can help to prevent data errors, but in certain situations it is insufficient, especially read-intensive operations.

For these reasons, Apacer has developed a mechanism known as Smart Read Refresh™, which is particularly helpful for reducing error bits in read-intensive operations. In fact, this mechanism can be beneficial even to drive operations that are not only read-intensive.

2. What is Read Disturb?

In the real world of SSD usage, there are not many situations that focus exclusively or almost exclusively on read operations. But there are a few. One of the most well-known is in the gaming industry, where a particular game's software may be saved onto a storage device and read many times as the game is repeatedly used over an extended period.

Some manufacturers have opted for MLC or 3D TLC NAND devices in read-focused operations, because they believe that since there is little write-usage involved, the chance of errors is minimal. However, this is an incorrect assumption. Flash memory is susceptible to read errors, especially in cases where geometries are limited, such as MLC and 3D TLC NAND.

In an NAND flash array, memory cells are arranged in long parallel strings. When a read operation occurs, both the word line that needs to be read and the other word lines that neighbor it will need to be activated. However, this can have the effect of slightly programming the other word lines, due to their proximity. If this happens multiple times, the other word lines may tend towards a programmed state. This can result in read-disturb errors.

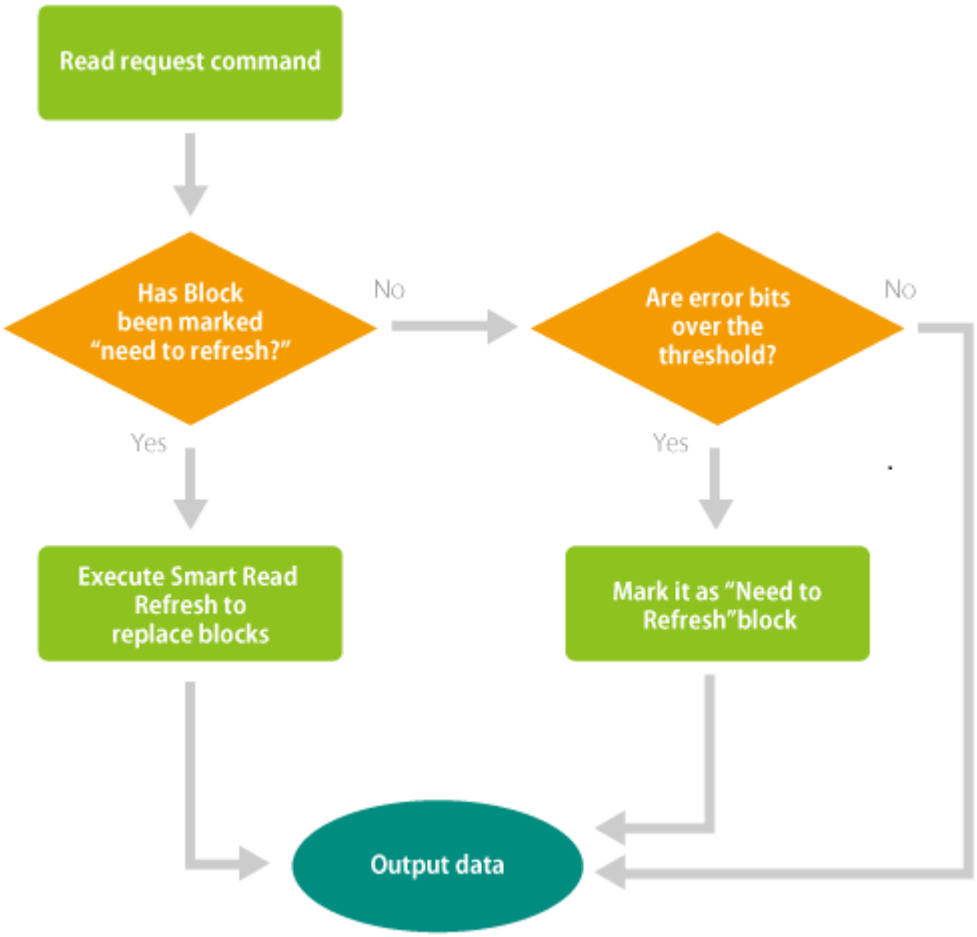
Read-disturb errors can also occur due to a buildup in noise from neighboring cells. The smaller the device geometry becomes, the more likely the noise is to cause interference. High operating temperatures can exacerbate the situation, as it increases the movement of charge to and from the memory cells.

Luckily, Apacer has developed a method to detect read-disturb errors and to minimize their negative effects. This method is known as Smart Read Refresh™.

3. What is Smart Read Refresh™?

Smart Read Refresh™ is designed to make sure that in read-intensive applications, blocks with a high number of errors can be removed and refreshed for further read operations. During each reach command, the controller will perform a two-stage check on the target block. First, it will check if the block has been marked “need to refresh.” If it has, the block will be refreshed before being read. If it has not, the controller will check the number of error bits currently present. If the number meets or exceeds the threshold for error blocks that has been set, it will mark the block “need to refresh,” meaning it will be refreshed during the next read operation.

A more detailed explanation of this process can be found in the following flowchart.



4. Conclusion

Users who are employing SSDs in read-intensive operations would be wise to consider implementing the Smart Read Refresh™ features. Common applications with read-intensive operations include GPS devices, server hosts and data sharing hubs, to name just a few. That said, even SSDs that are not designed for exclusively read-intensive operation can also benefit from Smart Read Refresh™. With Smart Read Refresh™, the chance of error bits being read during read operations is greatly reduced.

Revision History

Revision	Description	Date
1.0	Official release	2/14/2019

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