WEAR LEVELING WHITEPAPER

Whitepaper

Document #AN0027 – Viking Wear Leveling Whitepaper | Rev B

Purpose of this Document

This whitepaper was prepared to help OEM system designers evaluate the performance of Viking solid state drive solutions by using the same benchmarking methodology that Viking performs in it's SSD test facility. The SSD performance stated in the Viking SSD datasheets can be achieved by following the same Viking approach to SSD benchmarking which has been outlined in this document.

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1 Introduction

The wear leveling (WL) technique can extend the endurance and life of an SSD by working around the *block erase and program/ erase cycle limitations of* NAND flash devices. Wear leveling is one of the most widespread NAND management feature adopted by most SSD controllers.

Block Erase Principle

Before over-writing new data onto an existing block, it is required to erase a block in advance.

Program/ Erase Limitation

Flash memory has a finite number of program-erase cycle (P/E cycle). For SLC NAND, most flash manufacturers guarantee 100,000 P/E cycle, but for MLC NAND, it only has 3,000 - 5,000 P/E cycle.

Due to the shrinking of die process, it is getting more significant for SSD controller to implement techniques to improve the life time of the flash devices.

2 Wear Leveling Technique

Wear leveling is a technique for efficiently reducing premature wear-out in NAND flash devices and to achieve the specified endurance rating. There are two basic wear leveling mechanism used in flash devices: *dynamic and static.*

2.1 Dynamic Wear Leveling

The incoming data will be dynamically mapped across the entire SSD device. The firmware uses a map to link Logical Block Address (LBA) with Physical Block Address (PBA). Once data written into the specific physical blocks, the map will be updated to point to the new physical location. The data block containing the old data is then erased and made available as a free block.

How does Viking implement Dynamic WL?

Coverage: WL globally across flash PKG and die
Starting from Die#1 (CE0) of 1st flash, the transmit data will be broken into 8KB chucks and spread across the CE0 of each flash package. After transmitting size approaches xMB (decided by firmware), the dynamic WL will move onto the die #2 (next CE) across the flash PKG.

2.2 Static Wear Leveling

In contrast to dynamic wear leveling, static wear leveling distributes all block wearing evenly includes those data block is seldom been written to (E.g. most software almost not be moved once they were installed).

How does Viking implement static WL?

Coverage: WL within each flash package (can be across die)
Viking has two different mechanisms for triggering static wear level operation:

1. The erase count of the block of data going to be written > average erase count + X, it will be putted into a queue and not use, where X is an integer.

2. The erase count of the block of data going to be written > average erase count + Y, it will be swapped with the block of minimum erase count, where Y is an integer. Static wear leveling typically provides uniform block usage which means able to provide longer life expectancy. Moreover, dynamic wear leveling is easier to implement and can still provide enough wear leveling to meet the needs of many applications. Therefore, for achieving maximum benefit to drive's lifetime, most controller be implemented both techniques into the design.

3 Observing Wear Leveling Effectiveness with PhiMonitor Tool

Viking provides a SMART retrieval tool that tracks SSD's status. According to the SMART attribute- AD (Figure 1), you can determine

Max. erase count = 1199
Average erase count = 1139

Moreover, Wear range delta (B1) is another index that describes the effect of wear leveling. The formula for Wear Range Delta is:

$$\frac{Max.Erase\ Count - Avg.Erase\ Count}{Flash\ PE\ Cycles} * 100$$

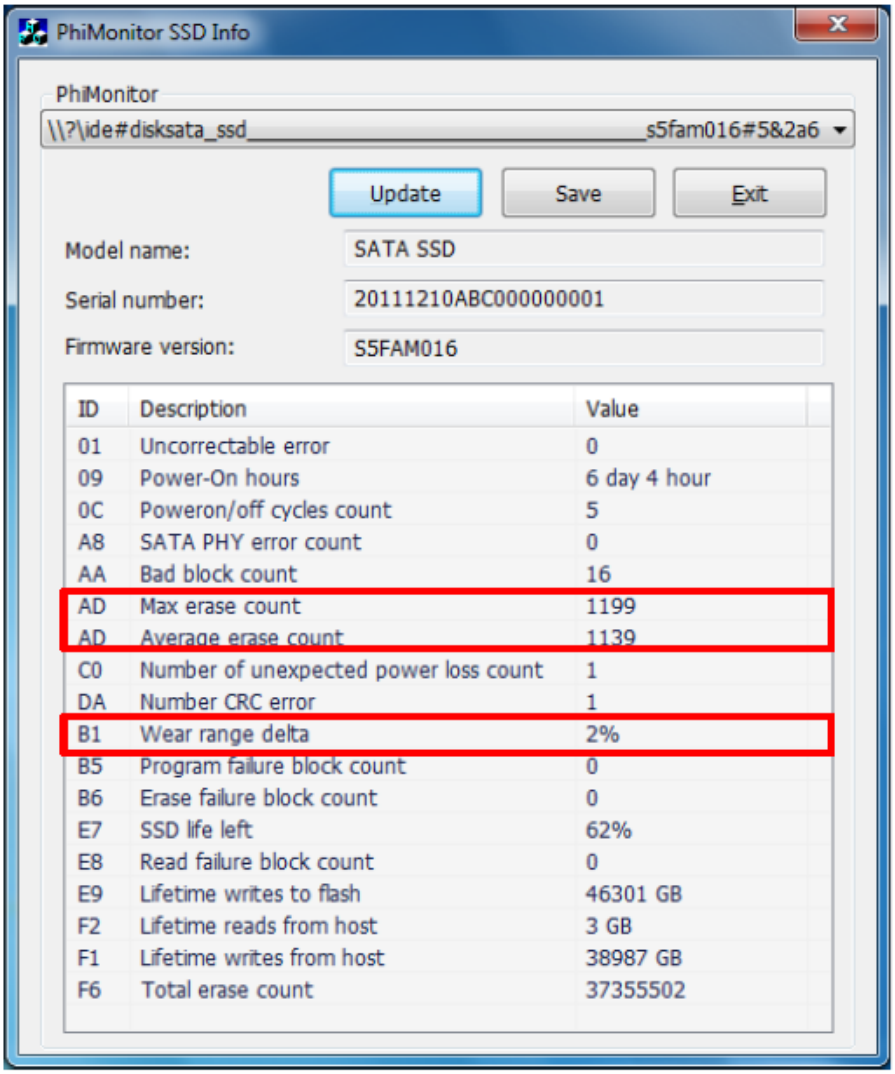

Figure 1. Viking S.M.A.R.T Retrieve Tool: PhiMonitor

About Viking Technology

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Global Locations		
US Headquarters	India Office	Singapore Office
2950 Red Hill Ave. Costa Mesa, CA 92626 Main: +1 714 913 2200 Fax: +1 714 913 2202	A 3, Phase II, MEPZ-Special Economic Zone NH 45, Tambaram, Chennai-600045 India	No 2 Chai Chee Drive Singapore, 109840
For all of our global locations, visit our website under global locations. For sales information, email us at sales@vikingtechnology.com		