STEC SMALL CARDS WEAR LEVELING AND LIFETIME CALCULATOR

INTRODUCTION

STEC Small Card family includes Secure Digital, miniSD, MMCPlus and SD High Capacity.
To build high quality and durable Industrial Grade Small Cards, STEC only uses Single Level Cell (SLC) Flash for its superior endurance, performance and reliability
In fact, STEC considers that Multi Level Cell (MLC) technology is not yet mature to be used in quality-demanding applications for the following reasons:

- Limited number of program/erase cycles per physical block: MLC flash is rated maximum 10,000 program/erase operations per physical block (with 4bit error correction) while SLC flash can perform 100,000 cycles (with 1 bit Error Correction).
- Slower speed operations: MLC is 4 times slower than SLC in program and 2 times slower in random access
- MLC Higher write and erase complexity increases the probability of bit fail

To enhance the Program/Erase operations of SLC flash, STEC Small Cards implement a powerful hardware Error Detection and Error Correction Code and a File System that translates the physical structure of the memory (pages and blocks) to operate on logical structure (cluster, sector and management units). The main component of STEC File System is the Dynamic Wear Leveling. The purpose of Wear Leveling is to ensure even distribution of Program/Erase cycles so that each block ages at the same rate.

The combination of the Wear Leveling and the powerful Error Correction Code enables the specification of the cards at 2,000,000 program/erase cycles for each logical block. On the SD card 1GB and 2GB the program/erase cycles are 300,000 due to the fact that these capacities use the latest flash technology components to provide better performance, cost optimization and long term support.

WEAR LEVELING

The minimum read and write operation unit inside a NAND flash chip is called a “PAGE.” Several pages form a Block that is the minimum erase operation unit. STEC Industrial Grade Small Cards group NAND flash blocks into several management units of 128MB. Wear leveling is implemented within a management unit. The reason of using management unit of 128MB instead of the full memory capacity is to be able to perform extensive wear leveling without jeopardizing the performance of the card.

The table below summarizes the page size, block size, number of pages per block and number of blocks per device:

	128MB	256MB	512MB	1GB	2GB
Page size	2Kbytes			4Kbytes	
Block size	128Kbytes			256Kbytes	
# of Pages per Block	64 Pages			64 Pages	

# of Block per device	1024	2048	4096	4096	8192
# of Management unit	1	2	4	8	16

When the host gives a write command to the card, the data is written into an empty physical block. Each block has a counter, and the wear leveling software makes sure that only the youngest block within a management unit is used for a new write operation.

The result is the rotation of the whole physical blocks within the management unit. Apart from blocks used to store static data, all the other blocks within a management unit are used for wear leveling operation. Static files (files that are not often updated) reduce the number of spare blocks available for wear leveling.

There are alternative solutions on the market that also use the blocks occupied by static files for wear leveling. As such, the number of blocks available for wear leveling might be higher. On the other hand, moving static data adds stress to the cell array because non-required write and erase operations are performed in back-ground by the controller. As a consequence, there are more chances to generate bit-flip errors and the performance of the card is significantly impacted.

When only one block is left empty, the write operation cannot be performed as the wear leveling cannot be executed and thus the firmware rejects the operation. Read and Erase operations are still available.

LIFETIME CALCULATOR

The lifetime of a STEC Small Card can be calculated as following:

Lifetime = 2Million x (C – Cs – 1B) / [max(block size, Fs) x Fr]

“C” is the capacity of the card
“Cs” is the Capacity used for static files
“1B” is one block (in fact, if only 1 block is empty, the write operation is not allowed)
“Block size” is 128Kbytes for 128MB-512MB and 256KB for 1GB and 2GB SD card.
“Fs” is the average File Size
“Fr” is the average frequency of file updating

Application Example:

Example #1
An application uses a 512MB SD card. 100MB of the card are used to store static data (i.e. the operating system). The rest of the card is used for updating 10 times per day a file of 50MB.
The lifetime can be calculated as following:

Lifetime = 2,000,000 x (512MB – 100MB – 128KB) / (50MB x 10/day) = 4,513 years

Example #2
An application uses a 64MB SD card. 50MB are used to store static data and the rest of the card is used for updating a file of 16KB 5000 times par day.
The lifetime can be calculated as following:

Lifetime = 2,000,000 x (64MB – 50MB – 16KB) / (16KB x 5000/day) = 980 years

IF YOU HAVE ANY QUESTIONS PLEASE CONTACT YOUR LOCAL STEC FIELD APPLICATIONS ENGINEER OR SEND A MESSAGE TO OEMSUPPORT@STEC-INC.COM

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