

XSR 1.5 BAD BLOCK MANAGEMENT

Application Note

May-2007, Version 1.0





Copyright Notice

Copyright © 2007, Flash Software Group, Samsung Electronics Co., Ltd

All rights reserved.

Trademarks

XSR is a trademark of Memory Division, Samsung Electronics Co., Ltd in Korea and other countries.

Restrictions on Use and Transfer

No part of this guide may be reproduced in any form or by any means (including electronic storage and retrieval or translation into a foreign language) without prior agreement and written consent from Samsung Electronics Co., Ltd. as governed by Republic of Korea and international copyright laws.

Readers of this document are not granted the right to distribute this document to any third party without prior written agreement from Samsung Electronics Co., Ltd.

Samsung Electronics Co., Ltd may make changes to the contents of this document any time without notice.

THIS DOCUMENT IS INTENDED ONLY TO ASSIST THE READER IN THE USE OF THE PRODUCT. SAMSUNG ELECTRONICS Co., Ltd. SHALL NOT BE LIABLE FOR ANY LOSS OR DAMAGE ARISING FROM THE USE OF ANY INFORMATION IN THIS DOCUMENT. SAMSUNG ELECTRONICS Co., Ltd. ASSUMES NO RESPONSIBILITY FOR ANY ERROR OR OMISSION IN INFORMATION CONTAINED IN THIS DOCUMENT, OR ANY INCORRECT USE OF THE PRODUCT.

Contact Information

Flash Software Group
Memory Division
Samsung Electronics Co., Ltd

Address: San #16 Banwol-Dong, Taeon-Eup
Hwasung-City, Gyeonggi-Do, Korea, 445-701

Introduction

There are several peripheral devices to a computer used for storing data, such as hard disk drives and floppy disk drives. Hard disk drives can be written to many times and, typically, can store a large amount of data. Floppy disk drives also can be written to physically same place many times, but, typically, store a smaller amount of data. Another peripheral storage device used to store data is a Read Only Memory (ROM). A ROM is a solid state memory device that can be programmed only once and then read many times.

Flash memory has been developed for use as a storage medium. In order to use flash memory as a storage medium, a flash file system and management software is used to manage the flash memory and to interface with the operating system of the host. Flash memory can be programmed and electrically erased many times. Typically, flash memory is erased using a block erase process. When a block erase process is employed, areas of a flash memory chip array, called blocks, are simultaneously erased.

While flash memory is a memory media that can be reprogrammed, prior to writing new data to a memory location that previously held data, the entire block that includes that memory location typically is erased to an all 1 state. While programming turns bits from “1” to “0”, block erasure is necessary to turn bits from “0” back to “1”. In a brand new device, all usable blocks are in the erased state. The erasing of an entire block may take several milliseconds depending on the type of flash memory. Furthermore, each time flash memory is erased and rewritten, the flash memory deteriorates. Once flash memory deteriorates to the point where the memory is no longer reliable or able to store data, that area of the flash memory is considered bad. Flash memory may be manufactured with bad areas and may develop bad areas for several other reasons.

Each block of the flash memory is limited in the number of times the data therein can be erased. Thus, if the number of times a block of the flash memory has been erased, exceeds the erase count as predetermined when it was manufactured at factory, the concerned block may turn bad, but it's not marked as a bad block until there occurs an erase/program failure.

A flash memory such as NAND flash memory may be manufactured with some bad blocks. Taking this

into consideration, the manufacturer directs users how to find the bad blocks therein.

When a read operation is performed in a block of a flash memory, different data from the data previously written in the block of the flash memory may be read, and at this time, the concerned block also turns bad. These bad blocks may be generated from any of the blocks while the flash memory is in use, or they may have existed even before the flash memory is used. Existence of the bad blocks may cause troubles when using the flash memory.

In summary, a need exists for a method of managing bad areas of flash memory such that information is reliably stored in the flash memory that does not require the use of extensive hardware. The invention is directed to fulfilling this need.

Recognizing Bad Blocks

Bad blocks of NAND flash may accumulate up to 2% of entire number of blocks during its manufacturing process and during the flash operational usage.

A system must be able to recognize bad block(s) based on the original bad block information and create a bad block table to keep track of blocks that fail during use. The first block of NAND Flash (block 0) is guaranteed to be good. The bad block information is stored in the reservoir area that is located in the highest address region of the NAND flash by XSR. Once the bad blocks have been located, Samsung recommends that the bad blocks be no longer accessed.

To locate the bad blocks on a brand new device, read out each block. Any block that is not all FFFFh in 1st sector of 1st or 2nd page in a spare area is a bad block. Figure 1 is a flowchart that shows how bad blocks can be detected by doing a read check on each block.

Although random bit errors may occur during use, this does not necessarily mean that a block is bad. Generally, a block should be marked as bad only when there is a program or erase failure. This can be

determined by doing a status read after erase/program operation.

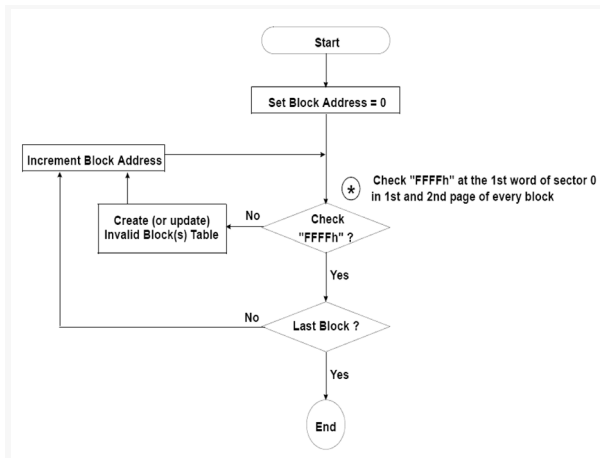


Figure 1. Bad Block Table Creation

Managing Bad Blocks

The flash memory is initialized by formatting the flash memory into a reserved area and user area. The reserved area blocks are called Reservoir in XSR

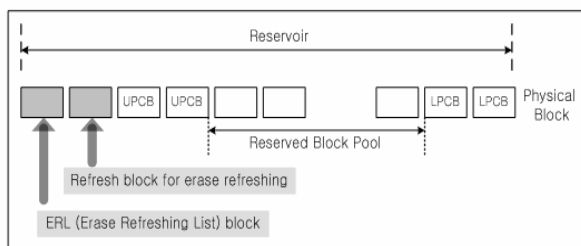


Figure 2. Reservoir Structure

Reservoir contains 6 meta blocks and several reserved blocks which is Reserve Block Pool for the replacement of bad blocks. The six meta blocks consists of pair of UPCB, a pair of LPCB, REF, and ERL. REF and ERL blocks are used for erase refresh scheme. UPCB is the acronym of unlocked reserved block pool control block and has the bad block mapping information of the unlocked area in the semi-physical address space. LPCB is the acronym of locked reserved block pool control block and has the bad block mapping information of the locked area in the physical address space. Locked Area is the area that must be protected from system crash or hacking after booting up. Locked Area can

not be written and erased after being booting up. Unlocked Area is the area that can be written and erased after being booting up. Reserved Block Pool is the pool of reserved blocks to replace bad block. The structure of UPCB is same as the structure of LPCB.

BMS is the acronym for Block Map Sector. BMS contains the mapping information from bad block of Partitions to reserved block of Reserved Block Pool. 4 sectors are reserved to store the bad block mapping information: there are 2 copies of sectors to store the original bad block mapping information. And there are 2 copies of sectors to store the mirrors of bad block mapping information.

The present process for handling bad block includes: finding the first available free reserved block number from the Reserved Block Pool, copying the content of bad block to free reserved block, registering new bad block mapping information, writing , and finally marking bad block.

Conclusion

In order to detect the initial bad blocks (generated during factory production) and to handle run time bad blocks (generated by program/erase usage), Samsung's XSR (Flash Driver) provides the Bad Block Management scheme. It remaps a bad block to one of the reserved blocks so that the data contained in a bad block is not lost and new data writes on a bad block is avoided .

Recommended Readings

- Samsung XSR 1.5 Porting Guide, April 2006
- Samsung XSR 1.5 Pre-Programming Guide, April 2006
- Samsung NAND Flash Specification