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SOFTWARE TECHNIQUES FOR FLASH
MEMORY

Replaced by: NONE

Power Fault Recovery Software Techniques for Flash Memory

This document describes power fault recovery software techniques for flash memory.

1 Introduction

A flash device must work correctly within the power supply operating voltage range. Power supply transitions outside the operating voltage range (faults) can result in read, erase, and program errors in flash memory. To prevent power supply related flash failures it is a good engineering practice to use recovery techniques to restore the integrity of the flash memory contents. This document describes power fault recovery software techniques for flash memory.

2 Power Fault Definition

After power on, the flash V_{CC} supply voltage must be maintained within the minimum and maximum operating values called out in the data sheet. These values can be found in the corresponding flash data sheet. Any supply voltage out of the operating range is called a power fault.

A power fault can result in access failures such as reading an incorrect value from the flash memory array, control registers, or status registers. Erase and program command sequences are used to change data stored in flash. These are also called embedded operations. Both operations take from several microseconds to several seconds to finish. If a power fault happens during erasing or programming, the operation may be interrupted and data in the erasing or programming area may become unstable.

Power faults cannot be avoided completely since a fault may be caused by power loss, interfering voltage, or unstable power supply conditions that are beyond the control by the system. Software techniques can be used to mitigate compromised flash data integrity in the event of a power fault during an embedded operation.

3 How to Recover Flash From a Power Fault

First there must be a way to recognize when an embedded operation has not completed successfully so that the system can return to the last stable operating condition and perform any necessary recovery operations. Because all volatile state is subject to loss during a power fault, the method to recognize successful completion of embedded operations must use non-volatile memory. This means each embedded operation needs to record in non-volatile memory an indication of successful completion for each embedded operation. This indication can be as simple as a bit, related to each memory area programmed or erased, being programmed after each embedded operation is completed successfully. Another approach is to program a data check value such as a checksum or cyclic redundancy check (CRC) value related to each embedded operation. A data check value provides a more comprehensive validation that the embedded operation recorded data correctly. The check value may be recorded for each embedded operation or only for groups of operations such as when an entire file of data is successfully programmed. The check value may be stored with the related data or it may be recorded in a separate location such as a header or directory that points to the location of the related data.

Software that manages the structure and integrity of data stored in flash is generally called a Flash File System (FFS).

A typical FFS verifies that the check value matches with the data on each read operation and will verify that all data blocks have valid check values during system start up. If invalid data blocks are found the FFS may be able to identify earlier versions of the same data blocks that were recorded correctly and copy or enable those blocks as the last valid copy. The blocks that are found to be invalid can be erased and returned to the set of available erased blocks.

It is possible for a power fault during an erase operation to damage the block being erased such that it will not be recovered by new erase operation. An FFS will recognize that the block is not returning to the erased condition and exclude the block from further use.

4 Summary

To provide reliable flash operation, the system design should provide an operating environment that meets the flash data sheet recommended operating conditions. However, even in the best system designs, power faults can still occur and cause data errors in flash memory. Software can be used to verify data integrity and return to the last valid data state that existed before a power fault caused damage. The details of detecting and recovering from power fault caused data errors are handled by most Flash File Systems.

Cypress® makes available a Flash File System for use with Cypress flash memories. More information on Cypress flash related software is available at:

<http://www.spansion.com/Support/Pages/DriversSoftware.aspx>

or from your local Cypress sales office

<http://www.spansion.com/About/Pages/SpansionOffices.aspx>

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**	—	—	08/30/2011	Initial version.
*A	5035706	MSWI	12/03/2015	Updated to Cypress template.
*B	5807144	AESATMP8	07/10/2017	Updated logo and Copyright.
*C	6263088	MSWI	07/26/2018	Obsolete document. Completing Sunset Review.

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Cypress Semiconductor
198 Champion Court
San Jose, CA 95134-1709

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