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# Technical Note: Flash Write Endurance

Validating the  
Manufacturer's Specifications  
for Write Endurance

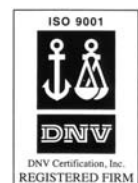
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## Introduction

The Adtron flash memory qualification process requires a validation of the flash memory manufacturer specification for write endurance. To accomplish this, Adtron developed a suite of software utilities that may be configured to focus high duty cycle erase/write activity to specific areas of the flash memory.

This document provides a brief test summary, description of the write testing process, and the accumulated results. The write endurance testing runs continuously. The current units under test are Hitachi 256 Mbit, multilevel cell flash.

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## Test Conditions

An Adtron special built test chassis holds up to 32 flash cards for simultaneous testing using the Adtron developed LoopTest software. For the purpose of this testing, write endurance is determined by measuring the sector sparing rate during high repetition rate sector writes. A sparing event replaces a failed sector with a new sector from the spare sector pool. This test is designed such that a sector failure occurs as a result of a write failure as the erase/write endurance limit is reached.

This process of measuring the sector sparing rate characterizes the flash erase/write endurance as well as the general quality of write sector error defect management. During the write endurance test, other operating conditions are set at a low enough level to prevent activating any other known operation-induced failure modes, e.g. read-disturb, etc.

The ongoing write endurance test utilizes 11 cards in two groups running the following tests:

- The same testing scenario applies to the two groups of flash cards with the following differences:
  - Four flash cards are written to in blocks of 15 sectors
  - Seven flash cards are written to in blocks of 45 sectors
- Write 100 blocks and make a test log entry
- After 1,000 block writes perform 1 read of the written blocks
- Periodically, the test is paused and the spare sector count is recorded

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## Results

The four card ongoing write endurance test was started in October 2000, and the seven card testing began in December 2000. These cards were removed from test to qualify next generation flash and controllers in January 2003 without data errors or card failures.

	Total sectors written	Average endurance
15 block group - 4 cards	$11.6 \times 10^9$	$1.6 \times 10^6$
45 block group - 7 cards	$30.8 \times 10^9$	$1.9 \times 10^6$

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## Conclusion

The Hitachi 256 Mbit flash devices tested demonstrate average write endurance above 1.5 million erase/write cycles.

Adtron performs write endurance testing in the process of qualifying new flash and controller technologies to ensure the write endurance levels meet or exceed customer requirements. While write endurance provides a general indicator of the life of service based on write activity levels, the actual life of a flash disk varies based on application parameters.

Adtron models the application and applies the expected write endurance combined with the error defect management characteristics to accurately predict the write endurance service life. Specifying flash drive service life for any critical application should include the enhancement benefits from the effects of sparing, striping and defect management.

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## Other Test Programs

Other testing performed to validate the reliability and durability of Adtron flash drives includes:

- Silicon aging test based on the activation energy and the Arrhenius model
- MIL-STD-810F shock, vibration and altitude testing