

Memory Testing Failures

Models, Algorithms, Current Test Analysis, Competitive Analysis



White Paper

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As part of our ongoing efforts to maintain our position as the world leader in diagnostics and system health we conduct studies of various hardware components. This paper is a brief summary of our most recent study on DIMMs (Dual Inline Memory Modules). It includes sections on the testing methodology and their results of this phase of the study. The results include competitive analysis of memory testing packages as well as the time to detect the memory failures.

[The PC-Doctor memory study is a work in progress as there is more data that can be collected and more conclusions drawn from that data.]

Conclusions

1. PC-Doctor had the highest detection rate in the lowest time per GB
2. PC-Doctor was the only diagnostic to catch 100% of failures
3. For factory testing when the memory is assumed good and there is a very low fallout rate we recommend running the Memory Fault + Address Fault test which take 9 s/GB.
4. For call center or assisted support we recommend running Advanced Pattern 4x4 which takes 91 s/GB
5. For depot repair of field repair we recommend running Advanced Pattern 4x16 or when the memory is suspect which takes 7:24 min/GB to run.
6. Many memory faults only showed on a subset of the systems. When possible memory should be tested in the system where it is used.
7. Windows memory testing is recommended for assisted support, but is not recommended for factory or repair use.

Method

Test Setup

367 pieces of DDR2 SODIMM were tested in this phase of the study. 22 notebook systems were used in testing the memory. To determine defective

memory modules, PC-Doctor Embedded Diagnostics*, Memtest 86+, Ultra X, and Microsoft Memory Diagnostics(preboot) were run on each memory. If the memory failed any test, that memory was considered defective. If the memory did not fail any of the tests, that memory was considered to have no defect.

Algorithm Study

50 new March algorithms were implemented and evaluated for test coverage and speed. These algorithms were implemented marching both bits and words.

Competitors Study

Memtest 86+, Ultra X, and Microsoft memory Diagnostic, were included in the test. These products were used as a baseline for detection and test time.

Test Improvement

During the study, improvements were made to the PC-Doctor memory diagnostics. These improvements were addition of the random pattern test and the addition of parameters controlling the number of patterns and number of phases used in the advanced memory test.

University Research

PC-Doctor partnered with the University of Reno, Nevada to analyze the resulting data from the memory study.

*DOS based or In-ROM based solutions. These solutions use common code and produce nearly identical results. The In-ROM solution can test a very small amount more memory than DOS but had no effect on the results.

Results

Diagnostic Comparison

Competitor's diagnostic software default tests were run. The PC-Doctor tests were run individually. Time to pass as detection percentage was calculated. Coverage is defined as the number of detected failures divided by the number of DIMMS that failed any test. The following table summarizes the findings:

Test	Coverage	Avg. Test Time / Gig
Microsoft (Extended)	89.47%	1:27:29
MemTest 86+	94.74%	0:26:15
Ultra X	94.74%	1:11:44
PC-Doctor Memory Tests		
Memory Fault	63.16%	0:00:06
Address Fault	65.79%	0:00:09
Memory Fault + Address Fault	68.42%	0:00:15
Advanced Pattern 4x4	83.33%	0:01:31
Advanced Pattern 4x8	91.67%	0:03:29
Advanced Pattern 4x16	94.74%	0:07:24
Random Pattern + Extended Advanced Pattern	100.00%	1:25:27

University Research

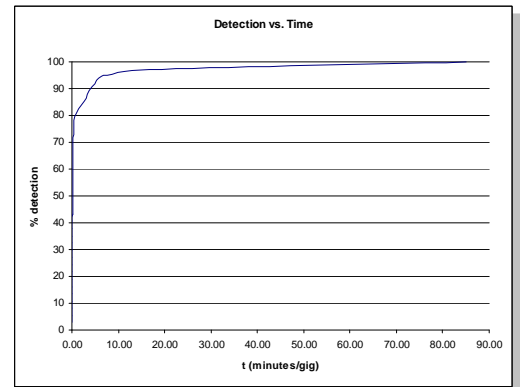
Ilya Zaliapin, Associate Professor in the Department of Mathematics and Statistics of the University of Nevada, Reno published a paper titled Detection of Memory Failures: Analysis of test duration and Choosing the Optimal Testing Strategy. This paper develops a model to determine optimal test time. This model includes the cost of test setup, the cost of test time, and the cost of an escaping defect. Using these three parameters the most cost efficient PC-Doctor test time can be selected. Using this model one could use custom numbers for the three costs and determine the optimal test time for the PC-Doctor memory tests.

The publication is available by request from PC-Doctor.

Test Time

Most failures can be detected by quite short tests, but the time to detect failures appears to grow exponentially. With respect to the PC-Doctor tests, about 95% of the failures can be detected in 7 minutes 30 seconds per gig of testing, but to detect the last 5 percent of failures the test time increased

to 1 hour 25 minutes. The following graph demonstrates this:



Memory Testing in Windows

More than half of the defective memory modules did not allow Windows to run and the PC-Doctor Windows memory test identified 61% of the remaining memory modules. Because of these two data points, testing memory in Windows is not an effective way to identify failing memory modules for factory or repair facilities even when taking into account the time to boot into another operating system such as DOS or PC-Doctor In-ROM.

However, if the goal is to exonerate the memory modules such as in a test on the customers system, the PC-Doctor Windows Memory test is an effective tool. Taking into account that more than half the modules would not run Windows, the PC-Doctor memory tests have an 82% coverage.

The test time for the PC-Doctor Windows memory test is about 3 minutes per gig.



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