AN503: Memory Options and Performance on nFORCE4 SLI Intel Edition Chip Set

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Introduction

This white paper will examine memory options for the nFORCE4 SLI Intel Edition chip set. We will give a brief summary of chip set features. We will then evaluate several memory modules that are suitable for use with this chip set. We will examine performance for these modules, and provide guidance for which memory types should be used based on target performance and cost of the system.

Chip Set Overview

The nFORCE4 SLI Intel Edition (abbreviated throughout the article as "NF4 SLI") is a performance-oriented chip set supplied by NVIDIA. A block diagram is shown in Figure 1. This chip set is the first core logic available for the Intel architecture that supports SLI. SLI is a technology developed by Nvidia which allows two video cards to be used in concert to drive one display with very good performance scaling.

The NF4 SLI utilizes DDR2 memory. As the chip set uses a dual channel architecture, memory should be used in pairs of similar modules to obtain optimal performance and stability. The NF4 is designed for the enthusiast market, so the BIOS supplied with the test platform allows extensive tweaking of memory settings. It is important to note that command rate can be specified with this chip set, a feature unusual for the Intel architecture. See Corsair's AN501 application note for more information on the impact of command rate on performance.

Memory Overview

The flexibility of the NF4 SLI memory interface makes it suitable for many memory types. Obviously, system performance will be impacted
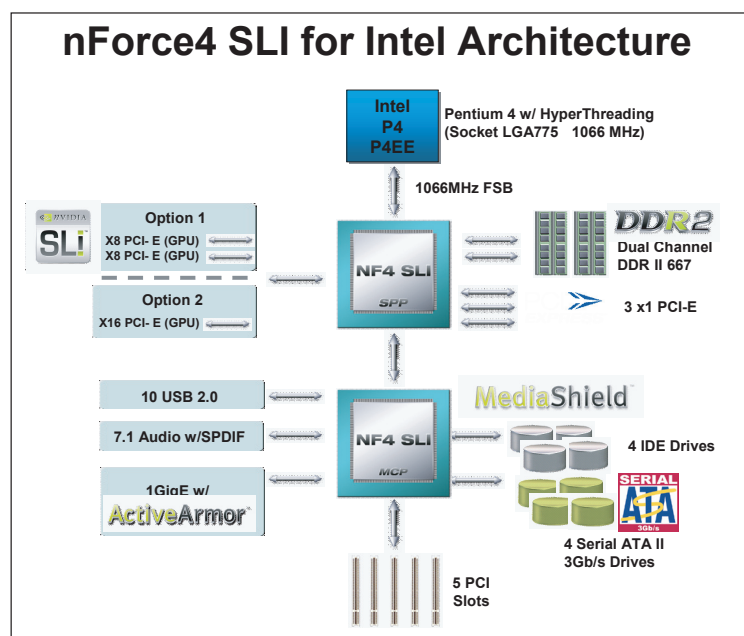

Figure1. NF4 SLI Block Diagram (source: NVIDIA Corp.)

Module Speed	Module Latency	Part Number (1 GByte Module Pair)	Performance Characteristics
675 MHz	3-2-2-8-1T	TWIN2X1024A-5400UL	Best performance at all settings
800 MHz	5-5-5-12-2T	TWIN2X1024A-6400	Optomized for maximum bus speed
667 MHz	5-5-5-15-2T	VS1GBKIT667D2	Low cost 667MHz solution
533 MHz	4-4-4-12-2T	VS1GBKIT533D2	Lowest cost, solid performance

Table 1. Memory Module Options for nFORCE4 SLI Intel Edition

significantly by the memory type chosen. In all cases, as with most recent chip sets, memory must be used in matched pairs to obtain optimum performance for a given set of memory settings.

We believe that the memory types shown in Table 1 represent the best Corsair product to use with the NF4 SLI. Product features are summarized below:

- TWIN2X1024A-5400UL: This XMS memory is the fastest memory offered for use in this board. It is a matched pair of 512 MByte modules, with operation guaranteed at 675MHz and 3-2-2-8-1T latency settings at an operating voltage of 2.1 volts. However, while there is no guaranteed operational specification at relaxed latencies, results of well over 800 MHz at 4-4-4-12-2T latencies are typically achieved. This part number represents a matched pair of single rank DIMMs based on very tightly screened 64Mx8 DDR2 DRAMs.

- TWIN2X1024A-6400: This module pair is overclocked to 800MHz and is tested at JEDEC-type (5-5-5-12-2T) latencies at an VDIMM level of 2.1 volts. It is not as fast as the 5400UL, but still provides excellent overclocking performance. This part number represents a matched pair of single rank DIMMs based on specially screened 64Mx8 DDR2 DRAMs.

- VS1GBKIT667D2: This part number represents a pair of matched 512 MByte DDR2 modules which utilize JEDEC standard DDR2-667 clock speeds and latencies. The modules may be either single rank (based on eight 64Mx8 RAMs) or dual rank (based on sixteen 32Mx8 RAMs). Overclocking is not tested or recommended for these modules.

- VS1GBKIT533D2: This part number represents a pair of matched 512 MByte DDR2 modules which utilize JEDEC standard DDR2-533 clock speeds and latencies. The modules may be either single rank (based on eight 64Mx8 RAMs) or dual rank (based on sixteen 32Mx8 RAMs). Overclocking is not tested or recommended for these modules.

While Corsair has other modules that are compatible with this chip set, we feel that the parts listed above provide the best coverage over both system cost and memory performance.

Test Setup

We decided to construct a test setup which would highlight the performance and features of the chip set and memory. With this goal in mind, an aggressive test platform was constructed

using the following components:

- Nvidia nFORCE4 SLI Intel Edition reference motherboard

- Intel Pentium 4 Extreme Edition, 3.73GHz, 1066MHz front side bus

- 2x GeFORCE 6800 Ultra PCI Express video cards

- Western Digital "Raptor" SATA hard drive

The four Corsair memory pairs listed above were benchmarked in this system using their guaranteed speed and latency settings. As with all benchmarks, system settings and component characteristics can greatly affect the benchmark scores measured. These tests represent results achieved in our lab under the conditions outlined in the paper. Your own results, of course, may vary substantially.

Benchmark Descriptions

The following benchmarks will be used to measure system performance:

- PCMark 2004 - Memory test suite. PCMark is designed to measure relative performance in general computing functions. The PCMark memory test suite focuses on system memory, so it makes a good measure of memory subsystem performance.

- SiSoft Sandra 2005 - This system diagnostic has a memory benchmarking tool that is designed to measure memory bandwidth. It provides two output values; one for integer processing, and one for floating point processing.

- Lavalys Everest - This program is very similar to SiSoft Sandra, and provides a memory bandwidth measurement benchmark. Everest provides two output values; memory READ bandwidth and memory WRITE bandwidth.

- Doom 3 timedemo, demo1 - This demo is included with the retail version of Doom 3, and provides a measurement of frames per second. By setting display resolution to 640x480 pixels, the benchmark score focuses on CPU/memory performance, rather than video card performance. This is a real-world benchmark, completely based on a retail game that is available to the public.

- Super Pi - Super Pi is a simple application which calculates pi to a specified number of digits. Two million digits were chosen for this benchmark rather than the one million more commonly used, as the one second resolution of the measurement did not provide adequate granularity for a system of this performance. We will measure the time in seconds it takes to complete this calculation.

- ScienceMark 2 Membench - This is another synthetic memory performance benchmark, which tests a series of different memory bandwidth algorithms. It provides a single memory bandwidth measurement score.

- 3DMark 2005. The 3DMark benchmarks are gaming-oriented, and are designed to estimate the relative gaming performance of the system. 3DMark 2005, the latest release of this popular benchmarking program, is benchmarked primarily as a reference, since changes in memory settings have a nominal impact on 3DMark scores.
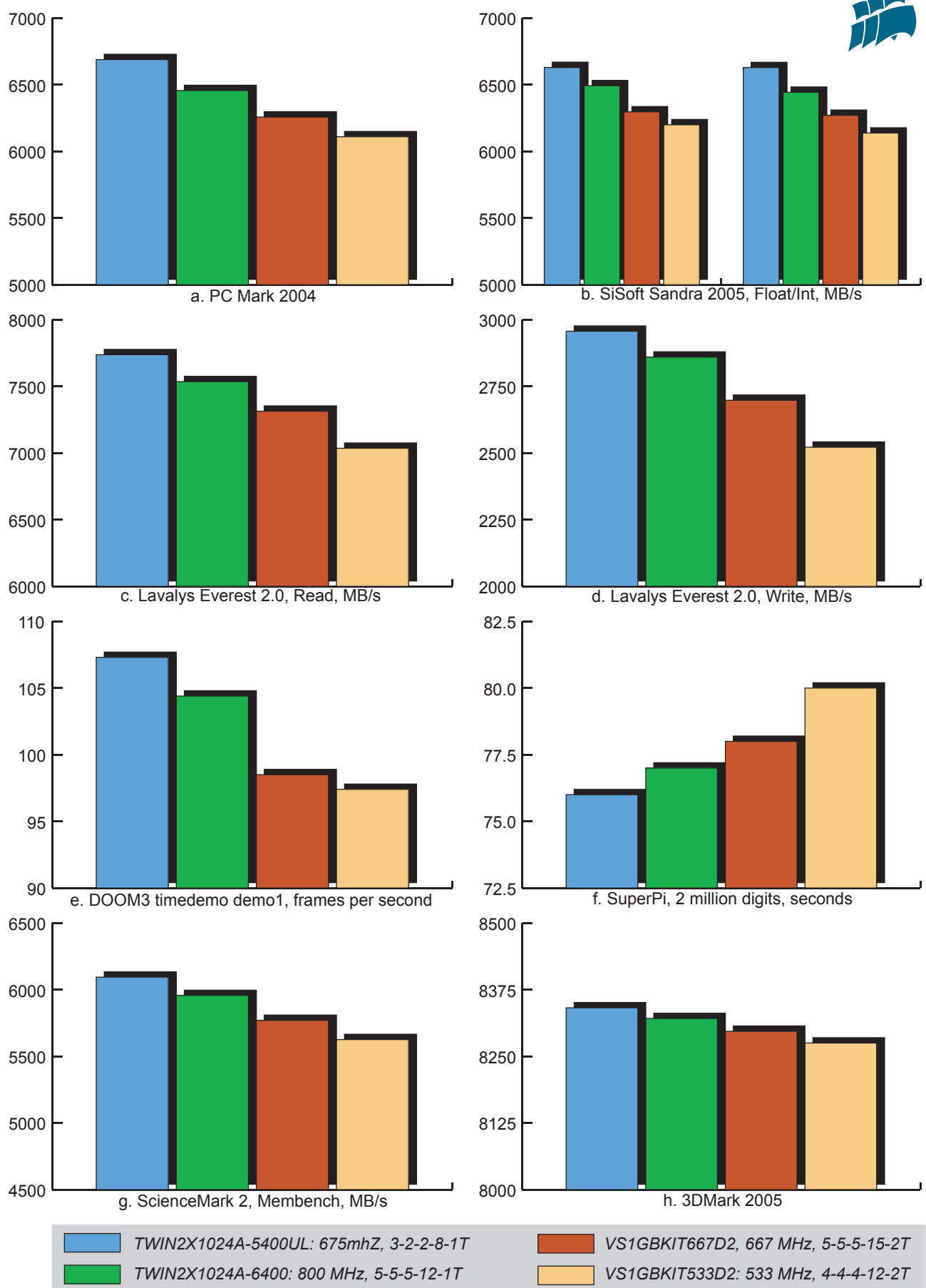
Figure 2. Benchmark Performance, by Memory Type

Legend:
- TWIN2X1024A-5400UL: 675mhZ, 3-2-2-8-1T
- TWIN2X1024A-6400: 800 MHz, 5-5-5-12-1T
- VS1GBKIT667D2, 667 MHz, 5-5-5-15-2T
- VS1GBKIT533D2: 533 MHz, 4-4-4-12-2T

Subplots:
- a. PC Mark 2004
- b. SiSoft Sandra 2005, Float/Int, MB/s
- c. Lavalys Everest 2.0, Read, MB/s
- d. Lavalys Everest 2.0, Write, MB/s
- e. DOOM3 timedemo demo1, frames per second
- f. SuperPi, 2 million digits, seconds
- g. ScienceMark 2, Membench, MB/s
- h. 3DMark 2005

Test Name	678 MHz 3-2-2-8-1T	800 MHz 5-5-5-12-2T	667 MHZ 5-5-5-15-2T	533 MHz 4-4-4-12-2T
PCMark2004 - Memory	6689	6647	6258	6110
SiSoft Sandra 2005 - Int	6630 MB/s	6493 MB/s	6297 MB/s	6200 MB/s
SiSoft Sandra 2005 - Float	6629 MB/s	6444 MB/s	6271 MB/s	6138 MB/s
Lavalys Everest 2.0 - Read	7738 MB/s	7536 MB/s	7314 MB/s	7036 MB/s
Lavalys Everest 2.0 - Write	2957 MB/s	2860 MB/s	2698 MB/s	2522 MB/s
Doom3 demo1 640 x 480	107.3 fps	104.4 fps	98.5 fps	97.4 fps
Super Pi 2M digits	76 sec.	77 sec.	78 sec.	80 sec.
ScienceMark 2 Membench	6094.34 MB/s	5956.43 MB/s	5769.96 MB/s	5625.78 MB/s
3DMark 2005	8341	8321	8297	8275

Table 2. Benchmark Results

Test Results

Test results are shown in Table 2, and in Figure 2a through Figure 2h. The tests were run for the following modules, which were set at their tested specification values:

- TWIN2X1024A-5400UL: 675 MHz (678MHz is the actual value BIOS would support), 3-2-2-8-1T latency, 2.1 volts

- TWIN2X1024A-6400: 800 MHz, 5-5-5-12-2T latency, 2.1 volts

- VS1GBKIT667D2: 667 MHz, 4-4-4-12-2T latency, 1.8 volts

- VSIGBKIT533D2: 533 MHz, 3-3-3-8-2T latency, 1.8 volts

In general, benchmarks which specifically focus on the memory subsystem showed a significant performance variance between the various configurations. Performance increases ranged from 7.5% on the Sandra benchmarks to 13.7% on the Everest benchmarks. Our two real-world benchmarks, DOOM 3 and Super Pi showed performance gains of up to 10.2% and 5.0%, respectively.

Optimal memory performance was attained by running at the maximum frequency achievable at aggressive latency settings. The very high memory bandwidth scores suggest that the memory subsystem of the NF4 SLI is very well tuned, and is nearly able to max out the front side bus of the processor.

Overclocking Results

After conclusion of the benchmark testing, the test platform was evaluated for overclocking capability using the TWIN2Z1024-5400UL. Tests were run to determine maximum system frequency both at tight (3-2-2-8-1T) and relaxed (5-5-5-12-2T) latencies. An overclock was considered successful if the system would boot into Windows XP, and would run the SiSoft Sandra benchmarks and the CPU-Z system diagnostic utility. The results were quite impressive; we were able to run at 693 MHz at 3-2-2-8-1T latencies, and 860 MHz at 5-5-5-12-2T latencies. Screenshots of the CPU-Z readouts are shown in Figure 3.
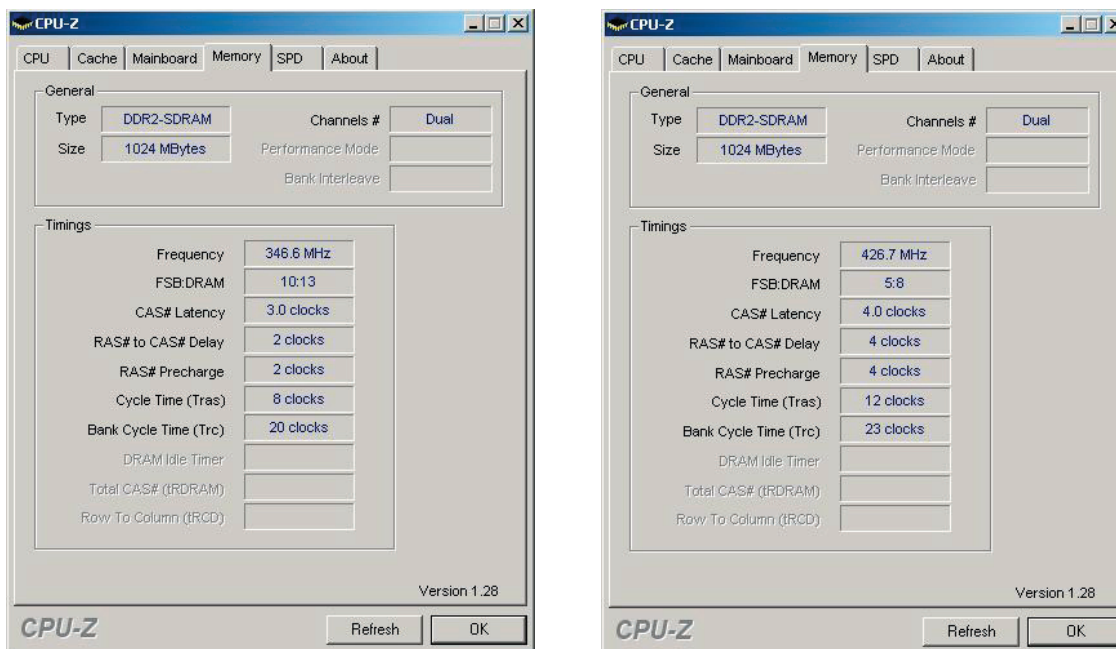
Figure 3. Overclocking Results, CPU-Z Screen Shots

Summary

The testing results make it clear that performance of this platform is heavily impacted by memory latency settings. For users who want to achieve the highest possible DDR2 memory bandwidth and system performance, the TWIN2X1024A-5400UL is the ideal memory choice. This module is able to run at a very high clock rate while maintaining very low 3-2-2-8-1T latency settings. The TWIN2X1024A-6400 is guaranteed at very high clock speed and more relaxed latencies, and also provides outstanding performance on this platform. If the system will not be overclocked, the VS1GBKIT667D2 and VS1GBKIT533D2 are an excellent memory selection, providing strong memory performance at their rated speed and latency settings.