# MDR Labs Performance Analysis of the 6x86 Microprocessor

*Application Note*

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Revision Summary: This is the third release of this Application Note. It contains a complete and unabridged reproduction of a performance analysis report (versions 3.0) produced by MDR Labs, Sebastopool, CA under contract from IBM Corporation and Cyrix Corporation.

6x86 PROCESSOR

*Manufactured by IBM*

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# MDR Labs

# Performance Analysis of the 6x86

**Version 3.0**

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# Scope

This report describes the methodology and results of a performance study conducted to compare 6x86 microprocessor performance on Windows applications to that of Intel's Pentium at various clock rates. Benchmarks were run on 6x86 processors running at 100, 120, 133, and 150 MHz and on Pentium processors at 120, 133, 150, 166, and 200 MHz. (Cyrix, IBM, and SGS-Thomson call the 6x86 parts the 6x86-P120+, P150+, P166+, and P200+, but we have identified them by their clock speeds.) Every effort was made to eliminate the influence of components other than the microprocessor by using matched system configurations.

This report presents data from Ziff-Davis' new Winstone 32, Winstone® 96, WinBench® 96, and SYSmark for Windows NT.

This project was performed under contract from IBM Microelectronics and Cyrix Corp. MDR Labs retained full control of the system configuration, software environment, and testing procedure. The systems as tested will be retained at MDR Labs for one year and are available for inspection by members of the industry.

# Testing Philosophy

## Goal

The methodology used in this study provides a precise measure of the relative performance of the two processors—for the chosen system configurations, on these benchmarks. The goal was to determine the relative performance of 6x86 and Pentium microprocessors on today's popular Windows applications, using system configurations typical of today's midrange and high-end PCs. Because the benchmarks available are all business application focused, the results do not necessarily reflect performance on 3D graphics or technical applications.

Different system configurations produce different relative performance levels, as each processor may be affected to a different degree by changes in other components. A full picture of a processor's performance must encompass a range of configurations. This report includes data for two memory configurations, but it is beyond the scope of this report to examine the effect of various disk and graphics subsystems.

## Isolating Microprocessor Performance

The performance of Windows applications is influenced by many factors:

- Microprocessor type and clock speed
- Chip-set design
- Main memory (DRAM)
- Disk drive and controller
- Graphics subsystem

To isolate microprocessor performance, all factors other than the processor were kept constant for each group of tests. The 6x86 and Pentium processors are pin-compatible, enabling a single motherboard to be used for both processors in many of the tests. (Because the 6x86-150 MHz uses a 75-MHz bus, however, it requires a different motherboard.)

## Selecting the System Configuration

Two memory configurations were tested for all except the fastest processors. The 256K cache/16M DRAM configuration is typical of midrange systems today, while the 512K/32M configuration is representative of high-end systems. EDO DRAM (with 60-ns access time) is widespread in performance-oriented PCs today. The hard disk drive and display adapter were chosen to represent practical, but leading-edge, peripherals.

Slower disk and graphics systems will produce significantly lower absolute results. The relative results for the two processors in a system with slower I/O systems will vary less than the absolute results, but they may also change; the benefit of a faster processor is less in a system that spends more time waiting for I/O devices.

Driver software for graphics controllers also plays a significant role. Depending on the coding style and instruction mix used in a driver program, one processor or the other may be disadvantaged. Thus, different drivers—even with the exact same hardware configuration— can produce different relative results between two processor types. For these tests, the current released driver was used for the graphics card.

## 6x86-150 MHz and Pentium-200 System Configuration

Different system configurations were used for the highest-speed parts. The 6x86 was tested in a motherboard designed to support the 150-MHz 6x86 operating in a 2x clock mode: i.e., with a 75-MHz bus. This is the system configuration recommended by Cyrix for use with this processor. (If a 150-MHz 6x86 system were to use a 3x clock, with a 50-MHz bus, it would result in significantly lower performance.)

The Pentium-200 processor was tested in a motherboard using Intel's Triton HX chip set. Because this motherboard does not support the 75-MHz bus speed used by the Cyrix 150-MHz processor, it was not appropriate to use the same motherboard for both processors. Thus, there are differences in hardware design between the two systems, but each is representative of high-end systems using each processor.

Other than the motherboard and chip set, all configuration parameters were held constant. Both systems use 256K bytes of synchronous burst cache memory and 32M of EDO DRAM. Both use a Seagate ST32550N 2G SCSI hard disk drive with an Adaptec AHA-2940 PCI SCSI controller and a Matrox Millenium display adapter.

## Selecting the Benchmarks

The relative performance of two microprocessors can vary considerably from one program to another, even with all other aspects held constant. Thus, the selection of the programs used for benchmarking can have a profound effect on the results.

For this study, we used the most widely-used benchmark suites for Windows programs: Ziff-Davis' Winstone 96 and WinBench 96, as well as the new Winstone 32. We also ran SYSmark NT as another measure of 32-bit performance.

The Winstone suite is composed of thirteen actual Windows applications, driven by scripts and sample data files. It reflects total system performance, including processor, memory, disk, and graphics, in the proportions used by these applications when running these scripts. It is indicative of performance on typical business applications; performance on computer-aided design or other technical applications may not be accurately portrayed. As the primary benchmark reported in PC Magazine, PC Week, and other Ziff-Davis publications, it is by far the most widely quoted Windows application benchmark. Results for a large number of systems can be found in these publications.

We ran Winstone 96 and Winstone 32 under Windows 95. (Note that Winstone 96 can also be run under Windows 3.11, producing different results; when comparing the performance of different microprocessors, it is important to compare results using the same operating system.) Winstone 96 consists of all 16-bit applications, even though they run under Windows 95;

Winstone 32 updates the applications with 32-bit versions. (Note that this testing was performed with a late beta version of Winstone 32. Later testing at Ziff-Davis has shown some variation between results from this version and the final version on some system configurations.)

We also ran portions of the WinBench 96 suite, which is designed to test individual subsystems. This benchmark uses synthetic programs: programs whose sole function is performance measurement. This allows the performance of various subsystems to be isolated. Predicting the performance of actual Windows applications from these results is more difficult, however; although the WinBench benchmark programs have been carefully designed to mimic application performance, synthetic benchmarks are often subject to anomalies.

## Isolating Other Software Effects

All Windows 95 configuration options were left at their default settings.

Disk fragmentation has a significant effect on system performance. To eliminate the influence of disk fragmentation, the test results reported for each chip and clock speed were produced immediately after formatting the disk and installing the software.

To minimize the effect of disk fragmentation during repeated tests (performed to ensure consistency of results), the disk was defragmented between benchmark runs.

# Test Results

## Overview

This section presents a quick overview of the relative test results, presented graphically for each clock frequency tested. Complete test results are shown in the tables in the following subsections, and configurations and test procedures are described in appendicies A and B.

Figure 1 shows the relative results for the 100-MHz 6x86 and 120-MHz Pentium on various benchmarks and memory configurations. Because the 6x86 uses a 2x clock multiplier, the bus runs at only 50 MHz, giving this part less bus bandwidth than other members of the family. The 100-MHz 6x86 is 1-2% slower than the Pentium-120 in most of our tests.

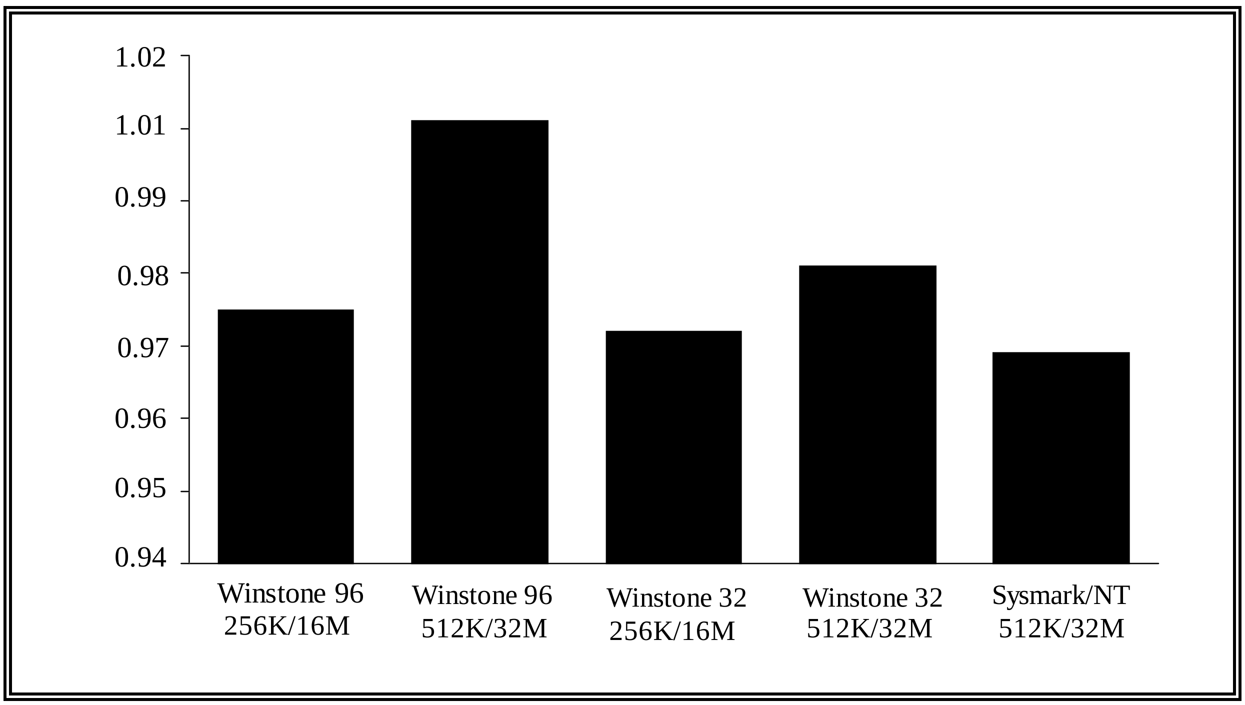


***Figure 1. MDR Labs results for the performance of the 6x86 at 100 MHz, relative to the performance of a Pentium-120 in an identical system configuration.***

As Figure 2 shows, the 120-MHz 6x86 retained an advantage of 4% to 5.5% over the Pentium-150 in our tests. The 133-MHz 6x86, shown in Figure 3, held a nearly constant edge of 5% relative to the Pentium-166.

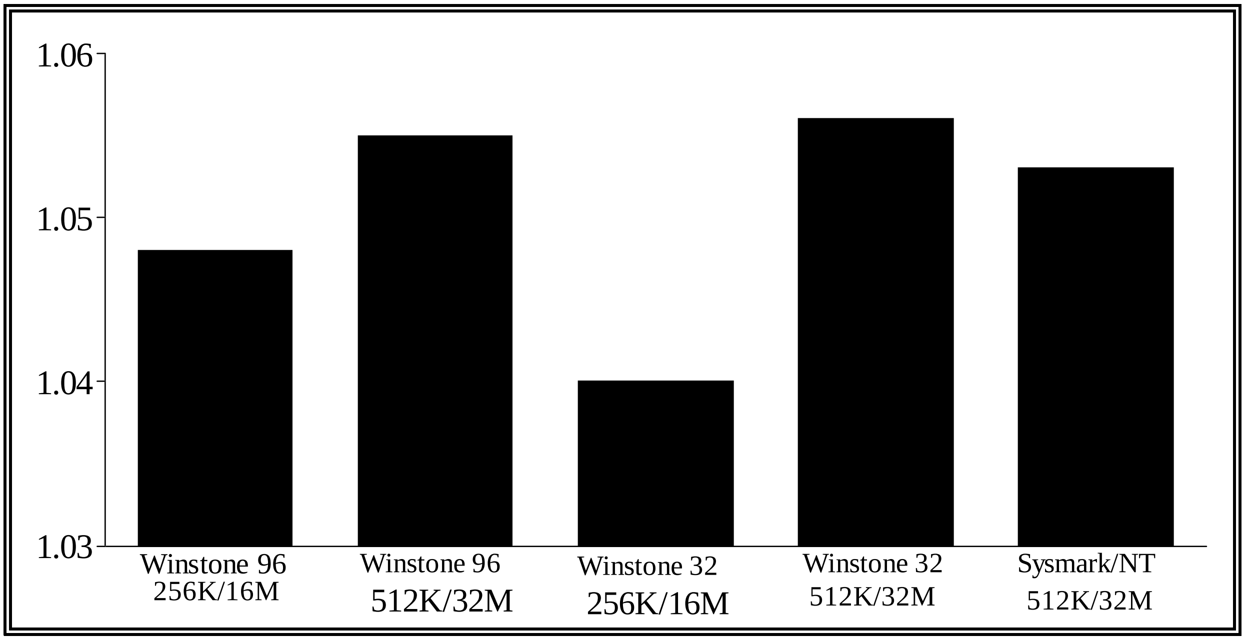


***Figure 2. MDR Labs results for the performance of the 6x86 at 120 MHz, relative to the performance of a Pentium-150 in an identical system configuration.***

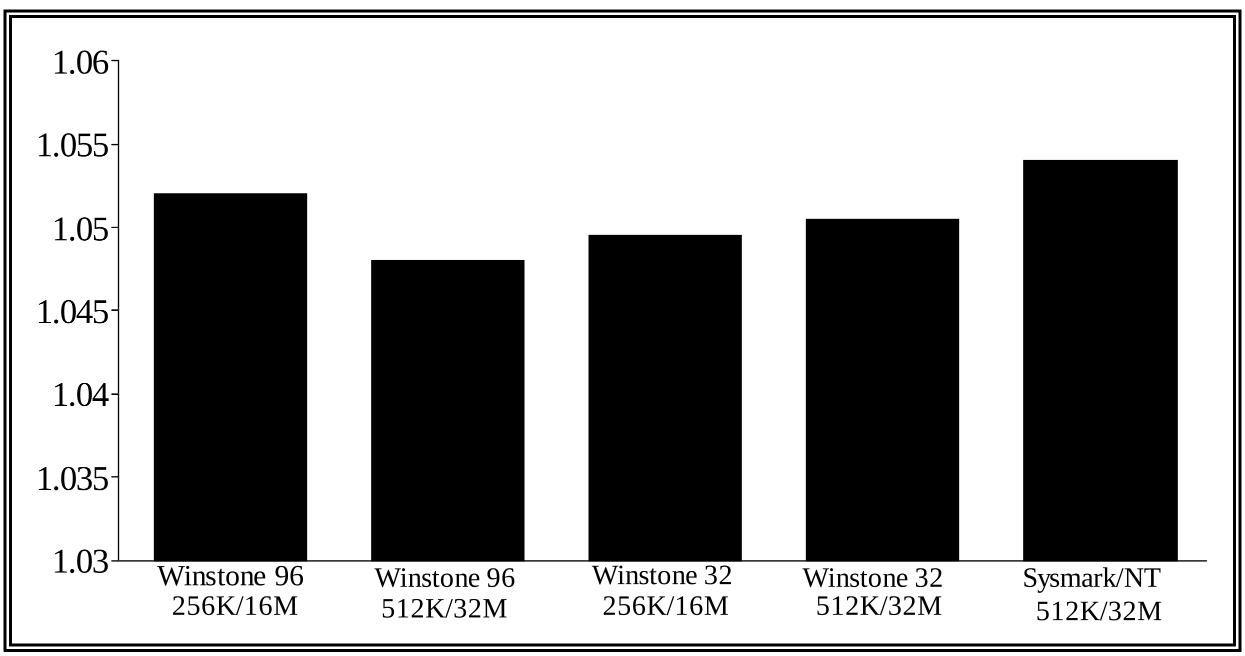


***Figure 3. MDR Labs results for the performance of the 6x86 at 133 MHz, relative to the performance of a Pentium-166 in an identical system configuration.***

All of the results presented to this point were measured using the same motherboard and peripherals, changing only the cache size, memory size, and benchmark. Figure 4 shows the results of tests done on another pair of motherboards, running the 6x86-150 MHz with a 75- MHz system bus. In this configuration, the 6x86-150 MHz achieved a 3% to 5% edge over the Pentium-200.

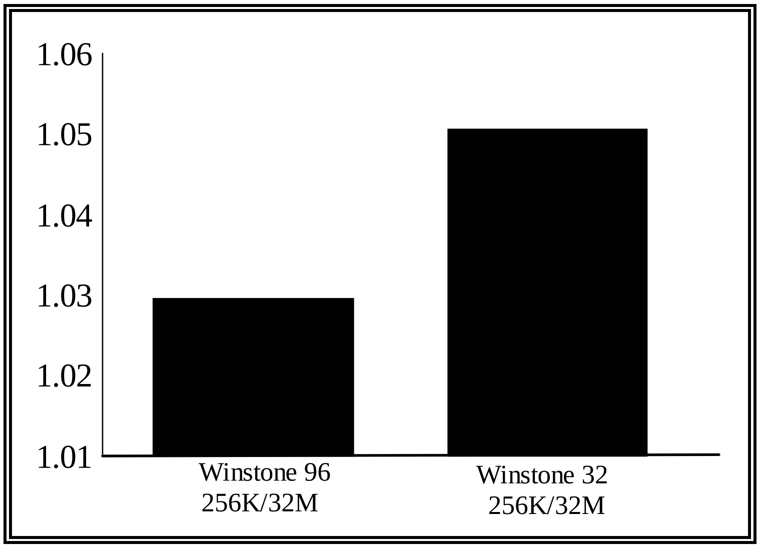


***Figure 4. MDR Labs results for the performance of the 6x86 at 150 MHz, relative to the performance of a Pentium-200 in a comparable system configuration. Both systems have 256K cache and 32M DRAM.***

## Winstone 96 and WinBench 96 Results: 256K/16M Configuration

Table 1 shows the Winstone 96 and WinBench 96 results for the smaller of the two memory configurations tested—256K cache and 16M DRAM. This data is the average of three runs. The variation among runs was well under 1%.

| | Pentium 120 MHz | 6x86 100MHz | Relative Perf. | Pentium 133MHz | Pentium 150MHz | 6x86 120MHz | Relative Perf | Pentium 166MHz | 6x86 133MHz | Relative Perf. |
|---|---|---|---|---|---|---|---|---|---|---|
| Winstone 96 | 67.8 | 66.8 | 0.986 | 72.5 | 73.1 | 76.6 | 1.048 | 77.9 | 81.9 | 1.052 |
| Bus. Graph | 6.7 | 6.6 | 0.990 | 7.2 | 7.3 | 7.6 | 1.050 | 7.8 | 8.1 | 1.047 |
| Database | 7.6 | 7.5 | 0.982 | 8.1 | 8.1 | 8.5 | 1.049 | 8.5 | 9.1 | 1.066 |
| SSheet | 6.2 | 6.2 | 0.995 | 6.7 | 6.7 | 7.1 | 10.54 | 7.1 | 7.6 | 1.065 |
| Word Proc. | 6.9 | 6.7 | 0.976 | 7.3 | 7.4 | 7.7 | 1.036 | 8 | 8.3 | 1.038 |
| CPUmark 16 | 250 | 228 | 0.911 | 278 | 288 | 277 | 0.963 | 317 | 307 | 0.971 |
| CPUmark 32 | 255 | 233 | 0.914 | 281 | 288 | 281 | 0.977 | 318 | 310 | 0.975 |
| Disk | 1100 | 1080 | 0.982 | 1140 | 1150 | 1153 | 1.003 | 1193 | 1210 | 1.014 |
| Graphics | 22 | 23 | 1.042 | 24.3 | 24.9 | 27.6 | 1.108 | 27.4 | 30.3 | 1.106 |

***Table 1. Winstone 96 and WinBench 96 benchmark results measured by MDR Labs for the 6x86 and Pentium processors in the Tyan motherboard with 256K synchronous burst cache, 16M EDO DRAM, Matrox Millenium graphics card, and Quantum Fireball 1G disk drive.***

The 100-MHz 6x86 delivered an overall Winstone 96 score 1.4% below the Pentium-120. It was strongest in the spreadsheet category, in which it was only 0.5% slower, and weakest in the word processing category, in which it fell behind by 2.4%.

The 120-MHz 6x86 delivered an overall Winstone 96 score 4.8% higher than the Pentium-150, while the 133-MHz 6x86 scored 5.2% higher than the Pentium-166. In both cases, the 6x86 outperformed the corresponding Pentium processor in every application category.

CPUmark 16 and CPUmark 32 , which are synthetic tests, show the 6x86 to be 3–6% slower than the corresponding Pentium. These benchmarks apparently do not precisely track the performance behavior of the applications used in the benchmark suites when comparing different microarchitectures.

## Winstone 32 Results for 256K/16M Configuration

Table 2 shows the Winstone 32 results for the same configuration.

| | Pentium 120MHz | 6x86 100MHz | Relative Perf. | Pentium 133MHz | Pentium 150MHz | 6x86 120MHz | Relative Perf. | Pentium 166MHz | 6x86 133MHz | Relative Perf. |
|---|---|---|---|---|---|---|---|---|---|---|
| Winstone 96 | 82.4 | 81.0 | 0.983 | 88.3 | 87.6 | 91.1 | 1.040 | 93.1 | 97.7 | 1.049 |
| Bus. Graph | 7.1 | 6.9 | 0.977 | 7.4 | 7.4 | 7.5 | 1.018 | 7.7 | 7.9 | 1.022 |
| Database | 9.9 | 9.6 | 0.970 | 10.7 | 10.6 | 10.8 | 1.019 | 11.1 | 11.8 | 1.057 |
| Word Proc. | 8.3 | 8.2 | 0.992 | 9.0 | 8.9 | 9.4 | 1.056 | 9.5 | 10.1 | 1.063 |

***Table 2. Winstone 32 benchmark results measured by MDR Labs for the 6x86 and Pentium processors in the Tyan motherboard with 256K synchronous burst cache, 16M EDO DRAM, Matrox Millenium graphics card, and Quantum Fireball 1G disk drive.***

The relative Winstone 32 results are quite similar to those for Winstone 96. The 100-MHz 6x86, which suffers from its 50-MHz bus, falls to 1.7% below the Pentium-120 on Winstone 32, but the other clock speeds show a 4%–5% advantage for the 6x86.

## Winstone and WinBench Results for 512K/32M Configuration

Table 3 summarizes the performance of a system with a larger cache memory (512K vs. 256K) and twice as much DRAM (32M vs. 16M).

On Winstone 96, the 6x86 ranged from 1% to 6% faster than the corresponding Pentium. Winstone 32 produced very similar relative results, except that the 100-MHz 6x86 (which suffers from its 50-MHz bus) dropped 1% below the Pentium-120.

| | Pentium 120MHz | 6x86 100MHz | Relative Perf. | Pentium 133MHz | Pentium 150MHz | 6x86 120MHz | Relative Perf. | Pentium 166MHz | 6x86 133MHz | Relative Perf. |
|---|---|---|---|---|---|---|---|---|---|---|
| Winstone 96 | 70.9 | 71.7 | 1.01 | 76 | 77.6 | 81.9 | 1.06 | 82.7 | 86.7 | 1.05 |
| Winstone 32 | 93.7 | 92.8 | 0.99 | 102.3 | 101.3 | 107.3 | 1.06 | 109.3 | 114.8 | 1.01 |
| CPUmark 16 | 263 | 247 | 0.94 | 294 | 307 | 298 | 0.97 | 340 | 329 | 0.97 |
| CPUmark 32 | 271 | 254 | 0.94 | 298 | 310 | 304 | 0.98 | 340 | 333 | 0.98 |
| Disk | 1120 | 1110 | 0.94 | 1140 | 1160 | 1180 | 1.02 | 1190 | 1220 | 1.03 |
| Graphics | 22.9 | 24.9 | 1.09 | 24.4 | 25.4 | 29.3 | 1.15 | 28.1 | 32.3 | 1.15 |

***Table 3. Winstone 96, Winstone 32, and WinBench 96 benchmark results measured by MDR Labs for the 6x86 and Pentium processors in the Tyan motherboard with 512K synchronous burst cache, 32M EDO DRAM, Matrox Millenium graphics card, and Quantum Fireball 1G disk drive.***

## SYSmark for Windows NT Results for 512K/32M Configuration

Table 4 shows the SYSmark for Windows NT results for the 512K cache and 32M DRAM configuration. The benchmark suite was run three times for each processor type and speed,with the results varying by plus or minus one unit (two units in one case). The ratings shown in the table are the averages of the three runs.

| | Pentium 120MHz | 6x86 100MHz | Relative Perf. | Pentium 133MHz | Pentium 150MHz | 6x86 120MHz | Relative Perf. | Pentium 166MHz | 6x86 133MHz | Relative Perf. |
|---|---|---|---|---|---|---|---|---|---|---|
| SYSmark/NT | 287 | 281 | 0.979 | 316 | 320 | 337 | 1.055 | 352 | 371 | 1.053 |
| SSheet | 266 | 252 | 0.949 | 293 | 290 | 303 | 1.045 | 319 | 334 | 1.046 |
| Proj. Mgmt | 253 | 281 | 1.112 | 279 | 274 | 341 | 1.242 | 302 | 371 | 1.228 |
| Word Proc. | 273 | 264 | 0.967 | 298 | 299 | 311 | 1.038 | 327 | 341 | 1.041 |
| Presentation | 344 | 292 | 0.848 | 381 | 391 | 352 | 0.900 | 433 | 389 | 0.898 |
| CAD | 308 | 321 | 1.043 | 341 | 360 | 387 | 1.077 | 398 | 430 | 1.080 |

***Table 4. SYSmark/NT benchmark results measured by MDR Labs for the 6x86 and Pentium processors in the Tyan motherboard with 256K synchronous burst cache, 16M EDO DRAM, Matrox Millenium graphics card, and Quantum Fireball 1G disk drive.***

The 100-MHz 6x86 fell short of Pentium-120 performance on the overall SYSmark result by 2.1%. Variation by application was considerable; the worst performance was on the presentation application (PowerPoint), where the 6x86 was 15% slower. At the other extreme, on the project management application (Texim Project), the 6x86 was 11% faster.

The 120-MHz 6x86 achieved an overall score 5.5% higher than the Pentium-150, while the 133-MHz 6x86 delivered an overall score 5.3% above the Pentium-166. For these speeds, the 6x86 was about 10% slower than the corresponding Pentium processor on the presentation program but outperformed it on all other programs in the suite.

## 6x86-150 MHz and Pentium-200 Results

Table 5 shows the results of the 150-MHz 6x86 and Pentium-200 tests. These tests do not use the Tyan motherboard, but instead use a DFI motherboard for the 6x86 that supports its 75- MHz bus speed. For the Pentium-200, a newer Tyan motherboard is used. Both systems in these tests use SCSI disk drives. (See system configuration section and Appendix B for details.)

| | Pentium 200MHz | 6x86 150MHz | Ratio 6x86/Pentium |
|---|---|---|---|
| Winstone 96 | 89.0 | 91.6 | 1.029 |
| Bus. Graph | 8.60 | 8.70 | 1.012 |
| Database | 10.17 | 10.53 | 1.036 |
| Spreadsheet | 8.20 | 8.50 | 1.037 |
| Word Proc. | 9.03 | 9.30 | 1.030 |
| Winstone 32 | 114.8 | 120.6 | 1.051 |
| Bus. Graph | 9.70 | 9.9 | 1.017 |
| Database | 14.7 | 15.4 | 1.043 |
| WP/SS | 11.4 | 12.2 | 1.64 |

***Table 5. Winstone 96 and Winstone 32 benchmark results measured by MDR Labs for the 6x86-150 MHz and Pentium-200 MHz processors with 256K synchronous burst cache, 32M EDO DRAM, Matrox Millenium graphics card, and Seagate ST32550N 2G disk drive.***

As the data in the table shows, the 6x86-150 MHz delivered a Winstone 96 score approximately 3% higher than the 200-MHz Pentium and increased its advantage to 5% on Winstone 32.

# Appendix A: System Configuration

Identical hardware and software was used for all of the tests in this report, except for the Pentium-200 and 6x86-150 MHz. The specifications for all other systems are as follows:

- Tyan Computer “Titan III” motherboard, with Intel Triton chip set
- 256K or 512K bytes synchronous pipelined burst cache RAM, 3-1-1-1 access
- 16M or 32M 60-ns EDO DRAM
- Matrox Millenium graphic board, 2M WRAM, 1024 ´ 768 ´ 256 colors
- Matrox display driver version 2.00.010 for Windows 95
- Quantum Fireball 1.08G disk drive, bus-master IDE interface
- Microid Research BIOS version 3.26 for 512K/32M tests
- Microid Research BIOS version 3.27 for 256K/16M tests
- Windows 95, first production release, default configuration

Because of the 6x86-150 MHz processor’s use of a 75-MHz bus, it was not possible to test the Pentium and 6x86 processors in the same motherboard. The two motherboards had the following features in common:

- 256K bytes synchronous pipelined burst cache RAM, 3-1-1-1 access
- Award modular BIOS version 4.51PG
- 32M 60-ns EDO DRAM
- Matrox Millenium graphic board, 2M WRAM, 1024 ´ 768 ´ 256 colors
- Matrox display driver version 2.30.049 for Windows 95
- Seagate ST32550N 2G disk drive, SCSI interface
- Adaptec AHA-2940 PCI SCSI adapter
- Adaptec SCSI driver version 1.21 for Windows 95
- Windows 95, first production release, default configuration
- 33-MHz PCI bus

Features specific to 200-MHz Pentium motherboard:

- Tyan S1562S motherboard
- Intel Triton HX chip set
- 66-MHz system bus

Features specific to 150-MHz 6x86 motherboard

- DFI G586VPS Pro motherboard
- VLSI Lynx chip set (VL82C541)
- 75-MHz system bus

# Appendix B: Test Procedures

## Basic Test Procedure

The procedure was as follows:

- Format disk drive
- Install Windows 95 with printer driver
- Install Ziff-Davis benchmarks
- Read license agreement and fill in disclosure document
- Turn off power, install appropriate processor, and set clock and bus speed jumpers
- Start system
- Repeat three times:
    - Defragment disk drive using Windows defrag command
    - Run Winstone 96
    - Print results and save to floppy disk

The WinBench tests were then run as follows:

- Repeat three times:
    - Defragment disk drive
    - Reboot
    - Run CPUmark16, print and save results
    - Reboot
    - Run CPUmark32, print and save results
    - Run Disk WinMark, print and save results
    - Run Graphics WinMark, print and save results

## SYSmark for Windows NT Procedure

For the SYSmark for Windows NT test, we followed the following procedure for each processor and clock speed:

- Formatted hard disk
- Installed Windows NT with printer driver
- Installed device driver for graphics card
- Copied all files from BAPCo CD to hard drive
- Ran setup.exe to install all applications
- Ran benchmark three times

## Special Test Procedure for Early 512K/32M Tests

When the initial 512K/32M configuration testing was performed in January 1996, the then-current version of the BIOS used in the tests (3.26) supported the 6x86 but did not fully optimize the configuration of the 6x86 processor. Two Cyrix-supplied utilities were executed from the floppy drive with the following command lines:

```
M1 -Q M1.CFG
BTB_ON.EXE
```

These utilities should not be needed for any production 6x86 systems, as BIOS code that supports the 6x86 has been updated.

The first of these utilities reads a series of values from the M1.CFG file and writes them to the configuration registers in the 6x86 processor. This sets up registers in the processor to properly configure it; the second utility enables another 6x86 feature by writing to additional control registers. These utilities affect only the 6x86-specific configuration registers and are required only because the early BIOS used for the initial tests, although it does minimally support the 6x86, leaves several important 6x86 features disabled.

After executing these programs, a soft boot was performed to restart the system with the new 6x86 register configuration. No Autoexec.bat or Config.sys files were used.

Microid Research BIOS versions 3.27 and newer, as well as other BIOSes, eliminate the need for these utilities. These utilities were used only the initial testing for this memory configuration; other tests were done with updated BIOS programs.

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