Pentium® II Processor Performance Brief

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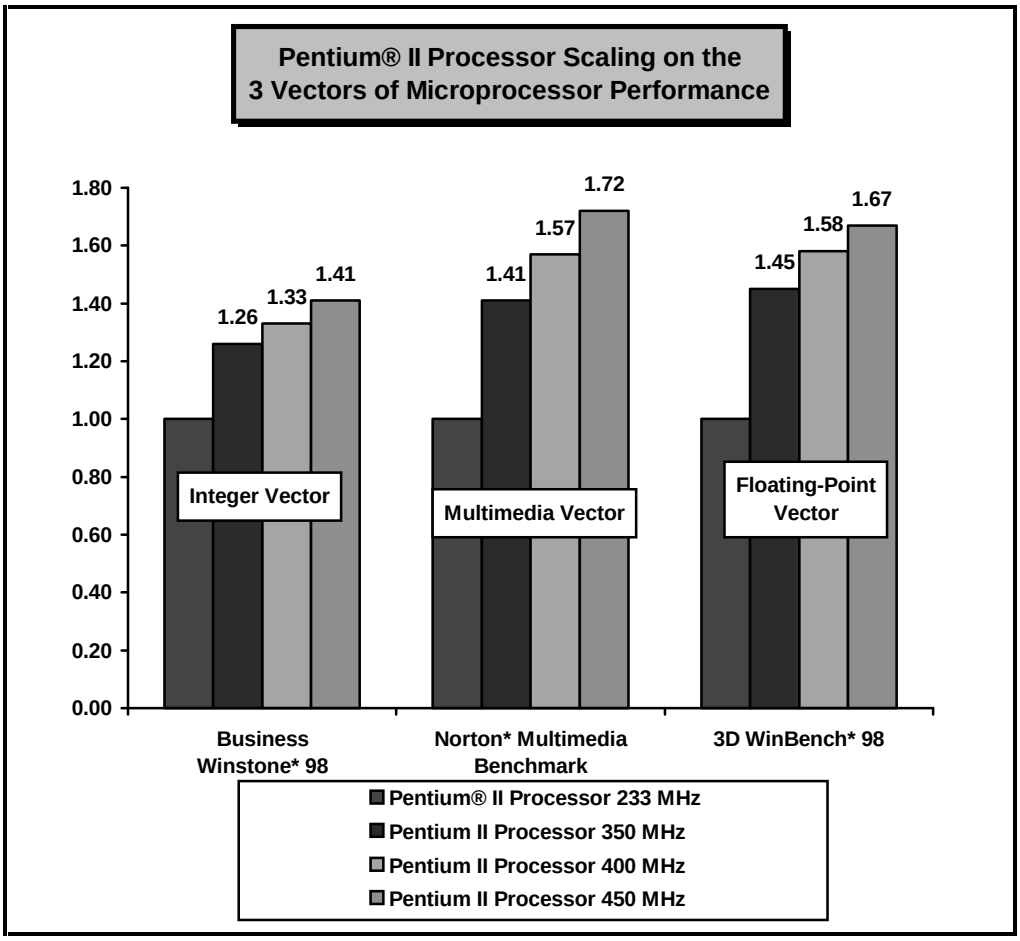
EXECUTIVE SUMMARY - INTEL® PENTIUM® II PROCESSOR

The Intel Pentium® II processor is Intel's highest performance desktop microprocessor. It combines the advances of the Intel P6 architecture with the instruction set extensions of Intel MMX™ technology to deliver excellent performance for today's and tomorrow's PC applications.

Additionally, the Pentium II processor delivers Intel's highest level of desktop performance for advanced media and communications software including powerful, realistic graphics and imaging capabilities, video conferencing, and the ability to run full-screen, full-motion video. The combination of these advanced technologies makes the Pentium II processor the ideal choice for executing modern 32-bit compute-intensive and multimedia-enhanced application workloads using advanced 32-bit operating systems.

The microprocessor and the PC of today are designed to run a broad range of powerful software applications. Not every processor is equally capable of the same performance for each type of application. Integer, multimedia (such as video and audio), and floating- point (such as 3D geometry calculations) performance comprise three vectors of performance that should be considered when evaluating systems. Specifically, benchmarks designed for evaluating these vectors should be used to examine the complete performance of a processor or system.

The graph below highlights Pentium II processor performance, relative to the 233 MHz Pentium II processor, on popular and industry standard benchmarks that demonstrate the three vectors of performance mentioned above.



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INTRODUCTION

The Pentium® II processor delivers Intel's highest level of desktop processor performance, and provides performance headroom for the advanced applications of tomorrow. It combines the power of the Intel® P6 architecture with the capabilities of Intel MMX™ technology. The newest member of this line is the 450MHz Pentium II processor, which runs with a 100 MHz system bus. The Pentium II processor desktop family consists of the following products:

- Pentium® II processor at 450 MHz
- Pentium® II processor at 400 MHz
- Pentium® II processor at 350 MHz
- Pentium® II processor at 333 MHz
- Pentium® II processor at 300 MHz
- Pentium® II processor at 266 MHz
- Pentium® II processor at 233 MHz

When evaluating the performance of a microprocessor, it is important to get a complete picture of how it executes various tasks. The increasing use of 3D and multimedia content in software today is placing new demands on the microprocessor. Typical productivity applications, such as word processing, presentation applications, or personal finance programs, require the processor to have good integer performance. Applications such as video playback, 3D games, and PC imaging stress the multimedia and floating-point capabilities of the processor and the system. For the best all around computation, a system should deliver high performance in all three of these areas: integer, multimedia, and floating-point.

This report provides benchmarks results for Intel Pentium II processor systems. Modern industry standard benchmarks were chosen to demonstrate the performance of the Pentium II processor for the three vectors of performance. Integer performance is measured by compute-intensive benchmarks such as SPECint*95 and several 32-bit Windows*95 benchmarks as well as more system oriented benchmarks like BAPCo's* SYSmark*32 test. Multimedia performance can be compared with the Norton* Multimedia Benchmark. Floating-point performance can be measured with the compute intensive SPECfp*95 or 3D Winbench*98. Intel is committed to using the most robust and relevant benchmarks in characterizing its products' performance and, over time, Intel will adapt this mix as newer benchmarks appear.

Robust benchmark programs should be derived from how actual applications will execute. Performance is often the result of combined characteristics of a given computer architecture and many other tightly coupled system software/hardware constituents in addition to the microprocessor. Operating system, compiler, library, memory design, and I/O subsystem characteristics may significantly impact the results and make comparisons difficult. This report illustrates Intel Pentium II processor performance on a consistent configuration. Details of the system configurations used for the benchmarks throughout this brief are described in Appendix A.

THE INTEL® PENTIUM® II PROCESSOR

The Intel® Pentium® II processor is Intel's highest performance desktop microprocessor. It combines the advances of the Intel P6 architecture with the instruction set extensions of Intel MMX™ technology to deliver excellent performance for today's and tomorrow's PC applications.

The Pentium II processor delivers Intel's highest level of desktop performance for advanced media and communications software including powerful, realistic graphics and imaging capabilities, video conferencing, and the ability to run full-screen, full-motion video. The combination of these advanced technologies make the Pentium II processor the ideal choice for executing modern 32-bit compute-intensive and multimedia-enhanced application workloads using advanced 32-bit operating systems.

The Pentium II processor may contain design defects or errors known as errata. Current characterized errata are available upon request.

PENTIUM® II PROCESSOR PRODUCT FEATURE HIGHLIGHTS

The Pentium II processor is fully compatible with an entire library of PC software based on operating systems such as MS-DOS*, Windows* 3.1, Windows for Workgroups* 3.11, Windows* 98, Windows* 95, OS/2*, UnixWare*, SCO UNIX*, Windows* NT, OPENSTEP*, and Sun Solaris*. Architectural features of the Pentium II processor include:

- Dynamic Execution Technology.

  ⇒ Dynamic execution incorporates the concepts of out of order and speculative execution. The Pentium® II processor's implementation of these concepts removes the constraint of linear instruction sequencing between the traditional fetch and execute phases of instruction execution. Up to 3 instructions can be decoded per clock cycle. These decoded instructions are put into a buffer, which can hold up to 40 instructions. Instructions are executed from this buffer when their operands are available (versus instruction order). Up to 4 instructions can be executed per clock cycle.

- Superpipelining.

  ⇒ The pipeline of the P6 processor family consists of approximately 12 stages versus 5 for the Pentium® processor and 6 for the Pentium processor with MMX™ technology. This enables the Pentium II processor to achieve about a 50% higher frequency than the Pentium processor on the same manufacturing technology. The sophisticated, two-level, adaptive-training, branch prediction mechanism of the Pentium II processor is key to maintaining the efficiency of the Pentium II processor's superpipelined microarchitecture.

- Dual Independent Bus (DIB) Architecture.

  ⇒ This architecture consists of two distinct buses emanating from the Pentium® II processor: the L2 cache bus and the system bus (used for memory and I/O requests). The L2 cache bus speed scales with processor frequency. For the Pentium II processor at 266 MHz, the L2 cache bus operates at 133 MHz, which is twice the speed of Pentium processor systems. The system bus for both processors runs at 66 MHz. The net result is that the Pentium II processor at 266 MHz has about 3X the peak bus bandwidth of the highest speed Pentium processor system, which has but one bus which runs at a peak of 66 MHz. Also, since speed of L2 cache accesses is one of the more important system factors in determining overall performance, system performance will scale well with higher processor frequencies. Unlike the Pentium processor's system bus, the Pentium II processor's system bus supports up to 8 outstanding bus requests (4 per processor). This allows more parallelism between processors and I/O, as well as supporting smooth performance scaling to a 2 processor system. The GTL+ electrical signaling of the system bus facilitates the migration of this bus to higher frequencies as higher performance DRAM technologies come to market.

- High Performance Intel® MMX™ Technology:

  ⇒ Intel's® MMX™ media enhancement technology is a major enhancement to the Intel Architecture which makes PCs richer multimedia and communications platforms. This technology introduces 57 instructions oriented to highly parallel operations with multimedia and communications data types. These instructions use a technique known as SIMD (Single Instruction, Multiple Data) to deliver better performance for multimedia and communications computation. Intel processors that provide MMX technology support are fully compatible with previous generations of the Intel Architecture and the installed base of software.

  ⇒ To further improve performance, the Pentium® II processor, like the Pentium processor with MMX™ technology, can execute 2 Intel MMX instructions at a time.

- Write Combining:

  ⇒ The Write Combining technology of the P6 architecture can be utilized to achieve very high graphics I/O performance. This feature combines multiple writes to a region of memory (for example, a video controller's frame buffer) declared as WC type into a single burst write operation. This is well suited for the bus, which is optimized for burst transfers. The combining also leads to burst writes of cache line sizes. These writes are further combined by the chipset leading to high throughput for graphics I/O. This will further enhance multimedia performance and enable more realistic full motion video and realistic, fast graphics performance.

- Caches:

  ⇒ The Pentium® II processor has 32 KB of non-blocking L1 cache, which is divided into a 16 KB instruction cache and a 16 KB data cache. Each of these caches run at the processor frequency and provide fast access to heavily used data.

  ⇒ The Pentium® II processor has a 512 KB L2 cache which is unified for code and data, and is non-blocking. There is a dedicated 64-bit bus to facilitate higher data transfer rates between the processor and the L2 cache.

- Floating-Point pipeline which supports the 32-bit and 64-bit IEEE 754 formats as

well as the 80-bit format. The FPU is object code-compatible with the Pentium® and 486™ processor FPUs.

- The GTL+ bus provides glueless support for two processors giving a cost-effective SMP solution. This can be used to significantly enhance OS and application performance in multi-threaded or multi-tasking environments or for functional redundancy checking.

- Testing and Performance Monitoring Features:

  ⇒ Built In Self Test (BIST) which provides single stuck-at fault coverage of the microcode and large PLAs, as well as testing of the instruction cache, data cache, Translation Lookaside Buffers (TLBs) and ROMs.

  ⇒ IEEE* 1149.1 Standard Test Access Port and Boundary Scan Architecture mechanism which allows testing of the Pentium®II processor through a standard interface.

  ⇒ Internal performance counters for performance monitoring and event counting.

INTEL® 440BX AGPSET PRODUCT FEATURE HIGHLIGHTS

The Intel® 440BX AGPset optimizes the performance of the Pentium® II Processor by implementing Intel Quad Port Acceleration (QPA). This capability improves system performance through four-port concurrent arbitration of the processor bus, graphics bus, PCI bus and SDRAM. The 440BX AGPset supports a system bus of 100MHz in addition to 66MHz while also increasing the width and depth of buffers to the system bus, AGP port, PCI bus and SDRAM.

iCOMP® INDEX 2.0

The iCOMP® index provides a simple relative measure of microprocessor performance. It is not a benchmark, but a collection of benchmarks used to calculate an index of relative processor performance intended to help end users decide which Intel microprocessor best meets their computing needs. iCOMP Index 2.0 comprehends:

1. The widespread use of 32-bit operating systems and applications on the desktop.
2. The proliferation of multimedia, communications and 3D applications.
3. Updated industry-standard benchmarks appropriate for emerging popular application profiles.

The iCOMP Index 2.0 ratings cannot be compared with the earlier version of iCOMP because a different base processor and different benchmarks were used.

The iCOMP Index 2.0 rating is based on the technical categories that encompass three separate aspects of 32-bit CPU performance: integer, floating-point, and multimedia. The multimedia portion is further divided into four sub-components: Audio, Imaging, Video and 3-D. The higher the iCOMP rating, the higher the relative performance of the microprocessor.

Figure 1 illustrates the iCOMP Index 2.0 ratings for seven Intel microprocessors. System configurations used in iCOMP Index 2.0 measurements are listed in Appendix B.

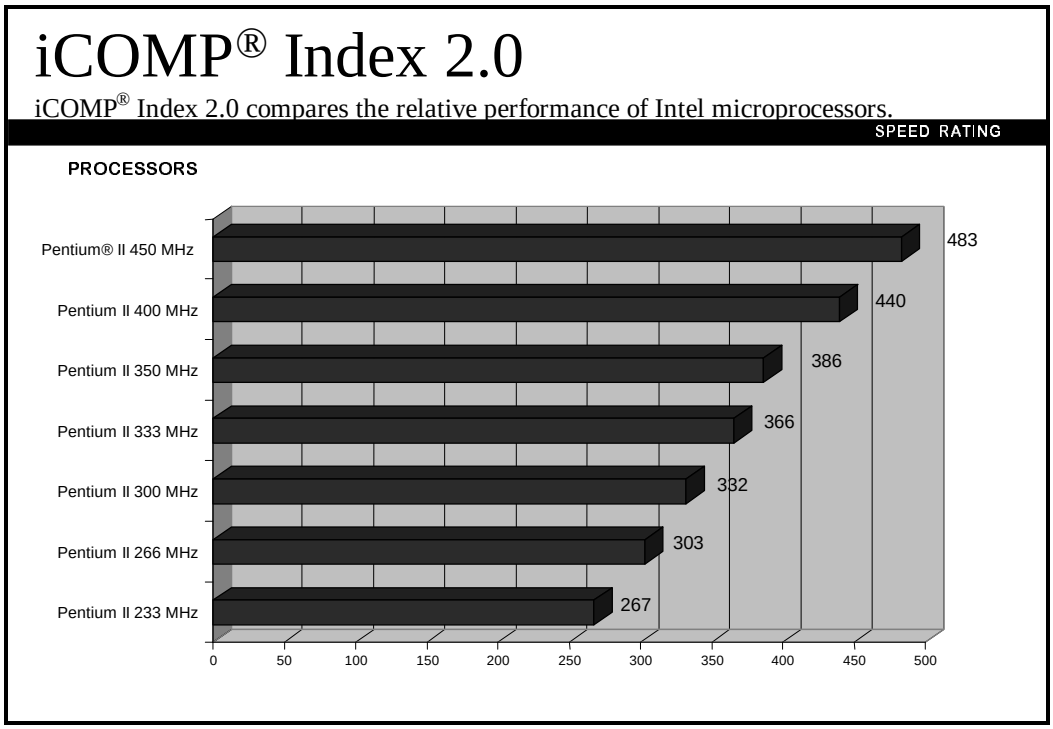

Figure 1. iCOMP® Index 2.0 Ratings for Intel Processors (System configuration for iCOMP Index 2.0 components is given in Appendix B)

iCOMP® Index 2.0 reflects the approximate, relative performance of Intel microprocessors on 32-bit applications and benchmarks. It combines five benchmarks: CPUmark*32, Norton*SI-32, SPECint*95, SPECfp*95, and the Intel Media Benchmark. Each processor's rating is calculated only at the time the processor is introduced, using a particular, well-configured, commercially available system. Ratings for Pentium® II processors were calculated with 512K L2 cache. Relative iCOMP Index 2.0 scores and actual system performance may be affected by differences in system hardware (other than microprocessors) or software design and configuration, including MMX™ media enhancement technology-enabled software. Buyers should consult other sources of information, including system benchmarks, to evaluate the performance of systems they are considering purchasing. For more information about iCOMP Index 2.0, including a description of the systems used to calculate ratings, and other information about microprocessor and system performance and benchmarks, visit Intel's World Wide Web site at www.intel.com and follow the appropriate links.

*Other brands and names are the property of their respective owners

3 VECTORS OF MICROPROCESSOR PERFORMANCE

The microprocessor and the PC of today are designed to run a broad range of powerful software applications. Not every processor is equally capable of the same performance for each type of application. Benchmarks specifically designed for evaluating the performance of processors and systems running integer-, multimedia-, and floating-point-,intensive applications should be used to examine the complete performance of a processor or system.

Integer Benchmarks

Typical productivity applications such as word processing, spreadsheets, presentation applications, and personal finance programs, to name a few, depend on integer performance. Popular, industry integer benchmarks include:

Processor Level Benchmarks:

- SPECint*95
- CPUmark*32
- Norton* SI32

System Level Benchmarks:

- SYSmark*32
- SYSmark*NT
- Business Winstone* 98
- High End Winstone* 98

Multimedia Benchmarks

Traditional benchmark tools were not designed to measure the performance of systems running today's applications rich in graphics, audio and video attributes. Multimedia benchmarks are designed specifically to simulate the activities of end users utilizing video, such as MPEG1* and MPEG2*, Dolby* Digital Sound, AVI, PC Imaging or Video Conferencing, and other similar media-rich applications. Some of the benchmarks that fall under this category are:

- Intel Media Benchmark
- Norton* Multimedia Benchmark from Norton* Utilities for Windows*95 Version 3.0

Floating-Point Benchmarks

Applications which use three-dimensional visualization techniques, such as games, are increasingly employing floating-point performance to support richer textures and enhanced lighting effects. Floating-point performance is also a critical factor for workstation applications such as Computer Aided Design (CAD). Benchmarks that measure floating-point performance include:

- SPECfp*95
- 3D graphics portion of the Norton* Multimedia Benchmark
- 3D WinBench* 98
- FPUmark* WinMark* Test

MICROPROCESSOR PERFORMANCE SUMMARY

Integer Benchmarks

Processor Level Benchmarks

SPEC CPU*95 - SPECint*95

SPEC CPU*95 is a software benchmark product which can be run on Windows*NT and many varieties of UNIX*. SPEC CPU*95 is produced by the Standard Performance Evaluation Corp. (SPEC), a non-profit group of computer vendors, system integrators, universities, research organizations, publishers, and consultants throughout the world. It was designed to provide measures of performance for comparing compute-intensive workloads on different computer systems. SPEC CPU95 consists of two suites of benchmarks: CINT*95 for measuring and comparing compute-intensive integer performance, and CFP*95 for measuring and comparing compute-intensive floating-point performance. The two suites provide component-level benchmarks that measure the performance of the computer's processor, memory architecture and compiler. SPEC benchmarks are selected from existing application and benchmark source code running across multiple platforms.

More information on SPEC CPU*95 can be found at the website http://www.specbench.org. The CINT95 suite, written in the C programming language, contains eight CPU-intensive integer benchmarks. It is used to measure and calculate the following metrics:

- SPECint*95 -- The geometric mean of eight normalized ratios (one for each integer benchmark) when compiled with aggressive optimization for each benchmark.
- SPECint_base*95 -- The geometric mean of eight normalized ratios when compiled with the conservative optimization for each benchmark.

For information on SPECfp*95, please refer to the Floating-Point Benchmark section of this document.

Figure 2 shows the SPECint*95 performance on Windows* NT 4.0. See Appendix A for configuration details.

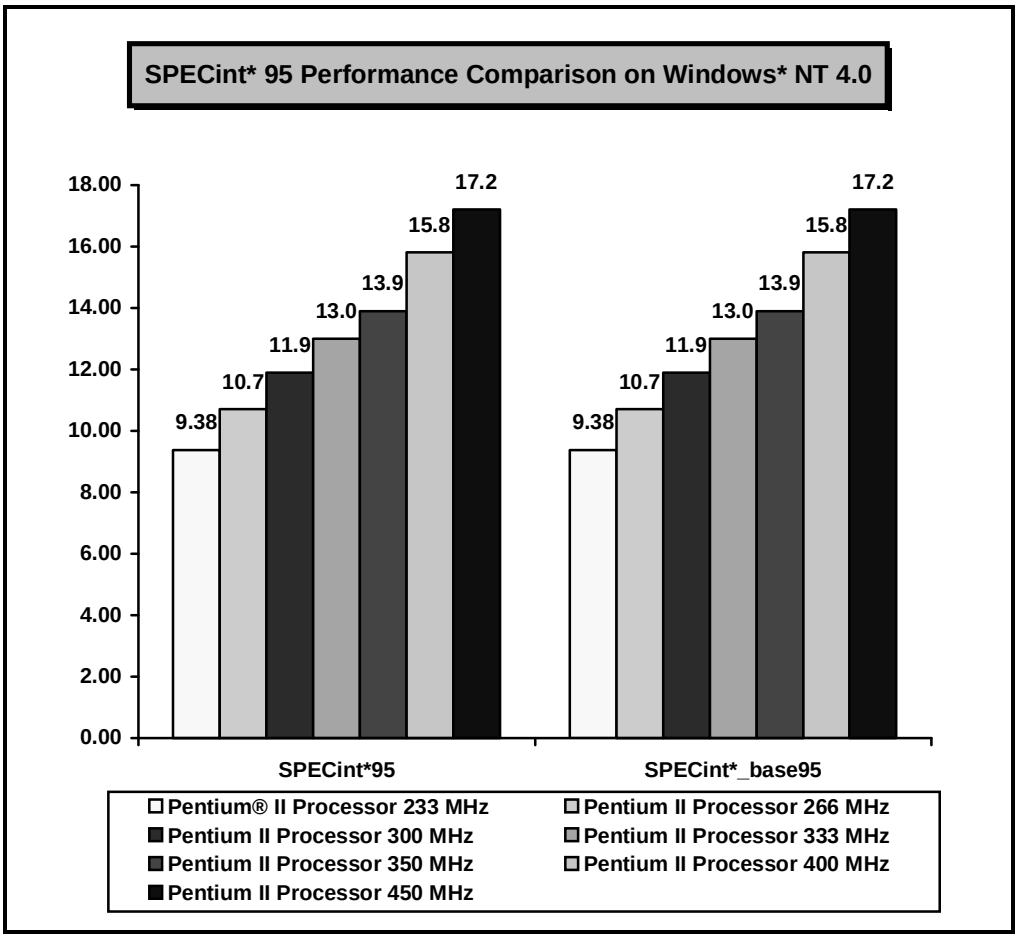

Figure 2. Intel® Pentium® II Processor Performance for the SPECint*95 Benchmark on Windows* NT 4.0

The SPECint*95 benchmark test provides a comparison point for the performance of the microprocessor, memory architecture and compiler of a computer system on compute-intensive, 32-bit applications. SPEC benchmark test results for Intel microprocessors are determined using particular, well-configured systems. These results may or may not reflect the relative performance of Intel microprocessor in systems with different hardware or software designs or configurations (including compilers). Buyers should consult other sources of information, including system benchmarks, to evaluate the performance of systems they are considering purchasing. For more information about SPEC*95, including a description of the systems used to obtain these test result, and other information about microprocessor and system performance and benchmarks, visit Intel's World Wide Web site at www.intel.com or call 1-800-628-8686.

CPUmark*32

CPUmark*32 is a 32-bit Windows processor benchmark provided by Ziff-Davis* Labs.

Figure 3 illustrates the Intel® Pentium® II processor performance on this popular 32-bit benchmark.

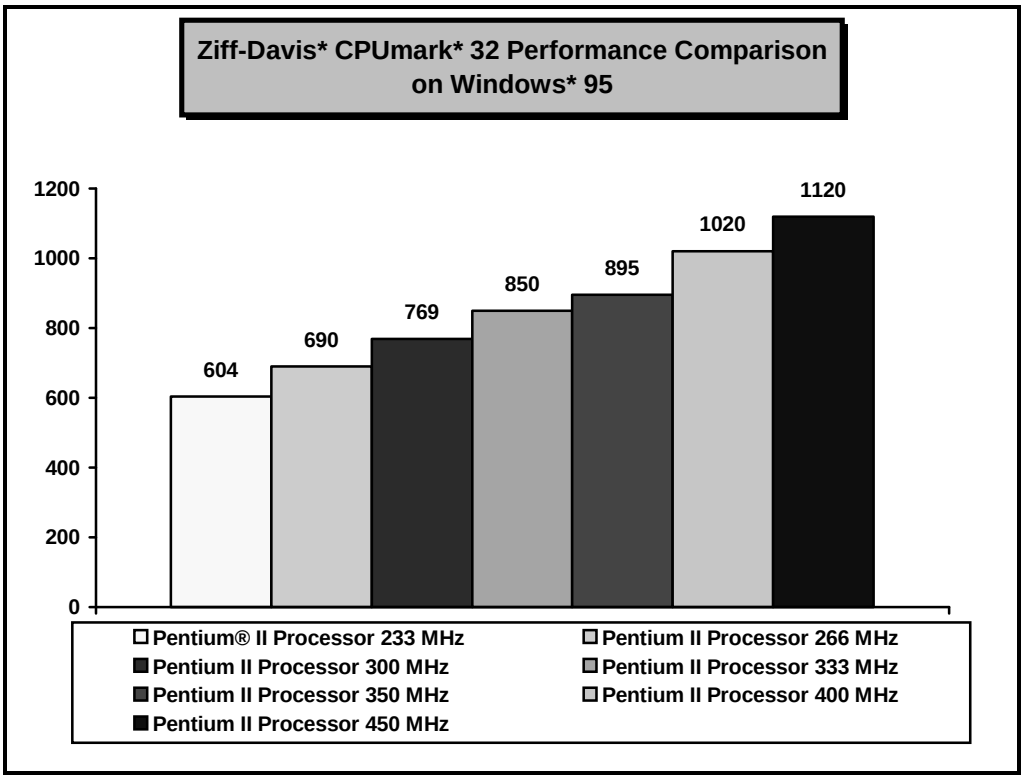

Figure 3. Intel® Pentium® II Processor Performance for the Ziff-Davis* CPUmark*32 Benchmark

Norton* SI 32

Norton* SI 32 is a 32-bit Windows* 95 benchmark designed to measure the speed of a system (CPU, L2 cache, and memory) compared to the speed of other systems on common 32-bit applications. This benchmark is part of the System Information module of the Norton* Utilities for Windows* 95 Version 3.0.

Figure 4 illustrates the Intel® Pentium® II processor performance when executing this popular 32-bit benchmark.

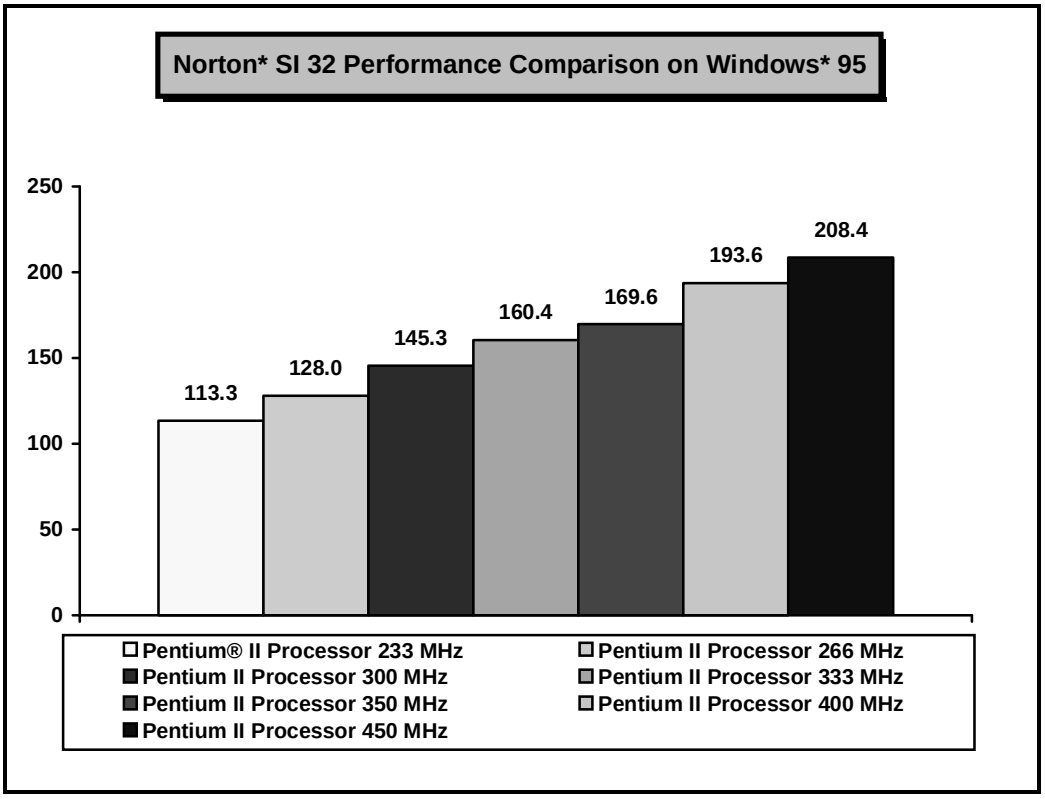

Figure 4. Intel® Pentium® II Processor Performance for the Norton* SI 32 Benchmark

System Level Benchmarks

To measure realistic application performance, SYSmark*32 for Windows* 95 and SYSmark* for Windows NT 4.0 (32-bit applications) were chosen to gauge the performance of Intel® Pentium® II processor-based systems.

SYSmark*32 For Windows* 95

SYSmark32* for Windows* 95 is a suite of application software and associated benchmark scripts that have been developed by the Business Applications Performance Corporation (BAPCo), a non-profit consortium of PC OEMs, software vendors, semiconductor manufacturers and industry publications. SYSmark*32 is intended to provide a tool for accurate and realistic measurement of personal computer performance running popular business-oriented applications in the Microsoft Windows operating environment. The scripts are developed to reflect usage patterns of PC users in a business-oriented environment.

SYSmark32 includes 32-bit benchmark scripts for the following applications selected from six categories of application software:

- Word-processing — Microsoft Word* 7.0 and Lotus WordPro* 96.
- Spreadsheet — Microsoft Excel* 7.0.
- Database — Borland Paradox*.
- Desktop Graphics — Corel CorelDraw* 6.0.
- Desktop Presentation — Microsoft PowerPoint* 7.0 and Lotus Freelance* 96.
- Desktop Publishing — Adobe Pagemaker* 6.0.

Figure 5 illustrates the SYSmark*32 rating under Windows* 95 for the Intel® Pentium® II processor.

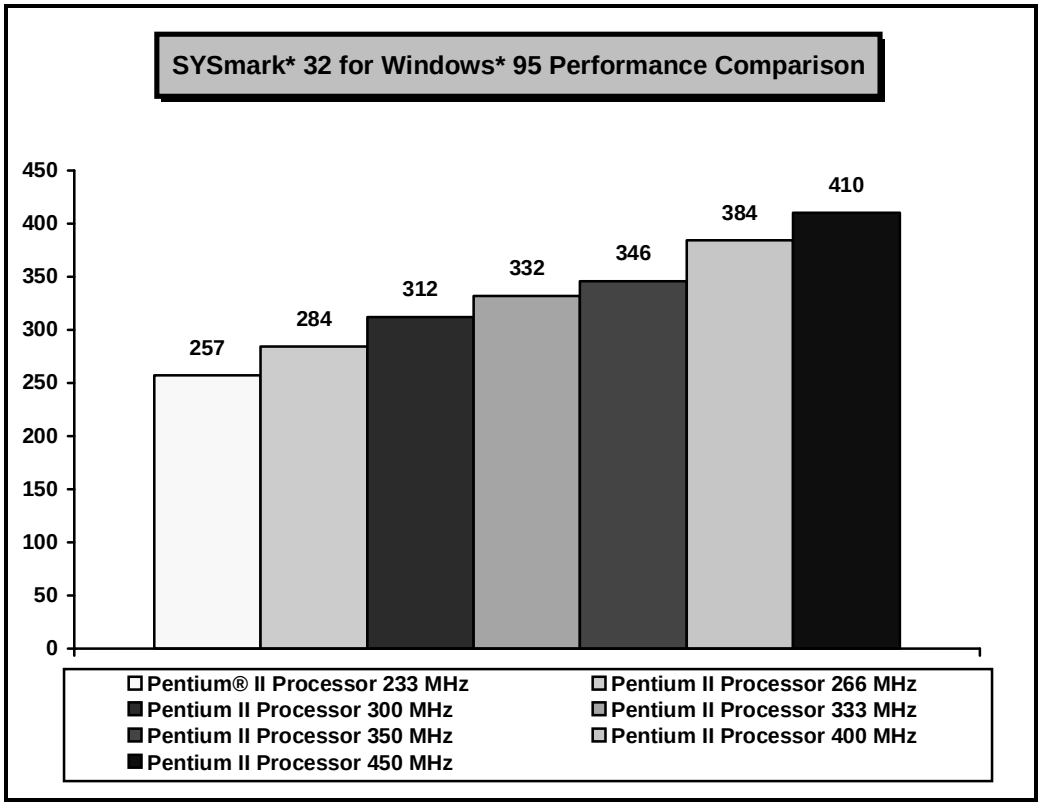

Figure 5. Intel® Pentium® II Processor Performance for SYSmark*32 on Windows* 95

SYSmark* For Windows* NT Version 4.0

SYSmark* For Windows* NT version 4.0 was developed to provide a benchmark that could be run on all platforms which support Windows NT. Workloads for SYSmark for Windows NT 4.0 were developed based on BAPCo's standardized practice of surveying users to determine how they exercise popular applications in day-to-day work. The following applications are included in SYSmark for Windows NT Version 4.0:

- Word-processing — MS Word* 6.0 (native 32-bit on all architectures)
- Spreadsheet — MS Excel* 5.0 (native 32-bit on all architectures)
- Project Management — Welcom Software Technology Texim* Project 2.0e (native 32-bit on all architectures)
- Computer-Aided Design — Orcad Layout* for Windows* 7.0 (PCB design tool) (native 32-bit on all architectures)
- Presentation Graphics — MS PowerPoint* 4.0 (16-bit Windows* emulation)

Figure 6 includes the SYSmark* NT Version 4.0 rating for Pentium ® II processors.

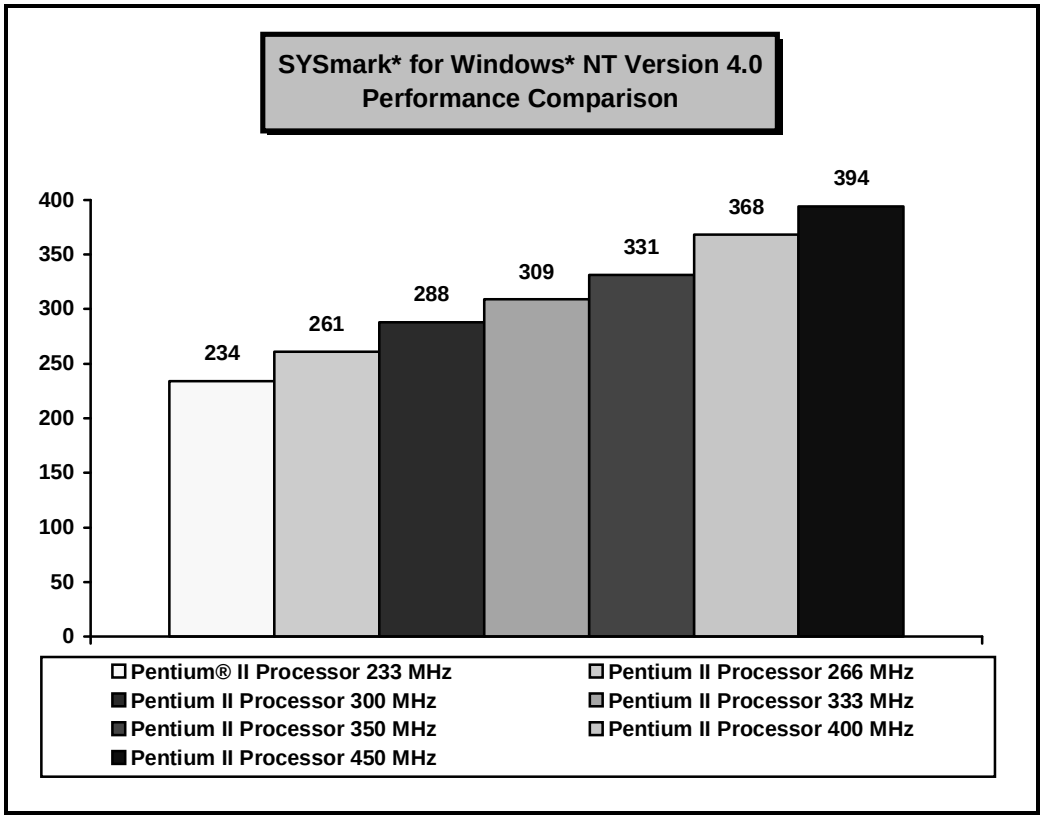

Figure 6. Intel® Pentium® II Processor Performance for SYSmark* for Windows* NT 4.0

Winstone® 98

Winstone® 98 is a system-level, application-based benchmark developed by Ziff-Davis*. It provides a means of comparing a PC's performance when running Windows*-based 32-bit applications. It runs real 32-bit applications through a series of scripted activities and then uses the individual script execution times and the unit market share of the business applications (or, in the case of the High-End applications, their editorially assigned weights) as determined by Ziff-Davis* to compute the scores.

The Business Winstone 98 applications are "market-centered" tests. The Business applications are the popular applications employed by many users everyday. The High-End Winstone 98 applications address the needs of users who employ demanding styles of work or specialized applications, such as photo editing or application development.

The categories used in Business Winstone 98 are:

• Browsers	Netscape Navigator*
• Publishing	CorelDRAW! * 7, Microsoft PowerPoint* 97
Spreadsheet/Database	Microsoft Access* 97, Microsoft Excel* 97, Lotus 1-2-3* 97, Corel Quattro* Pro 7
• Word Processing	Microsoft Word* 97, Corel WordPerfect* 7

The applications in High End Winstone 98 are not grouped into categories:

The Winstone* 98 High-End applications are: Adobe Photoshop* 4.01, Adobe Premiere*, AVS/Express* 3.1, PV-Wave* 6.1, Microsoft FrontPage* 97, and MicroStation* 95.

Figure 7 and 8 illustrates the results for Business Winstone 98 for Windows 95, and High End Winstone 98 for Windows NT 4.0, respectively.

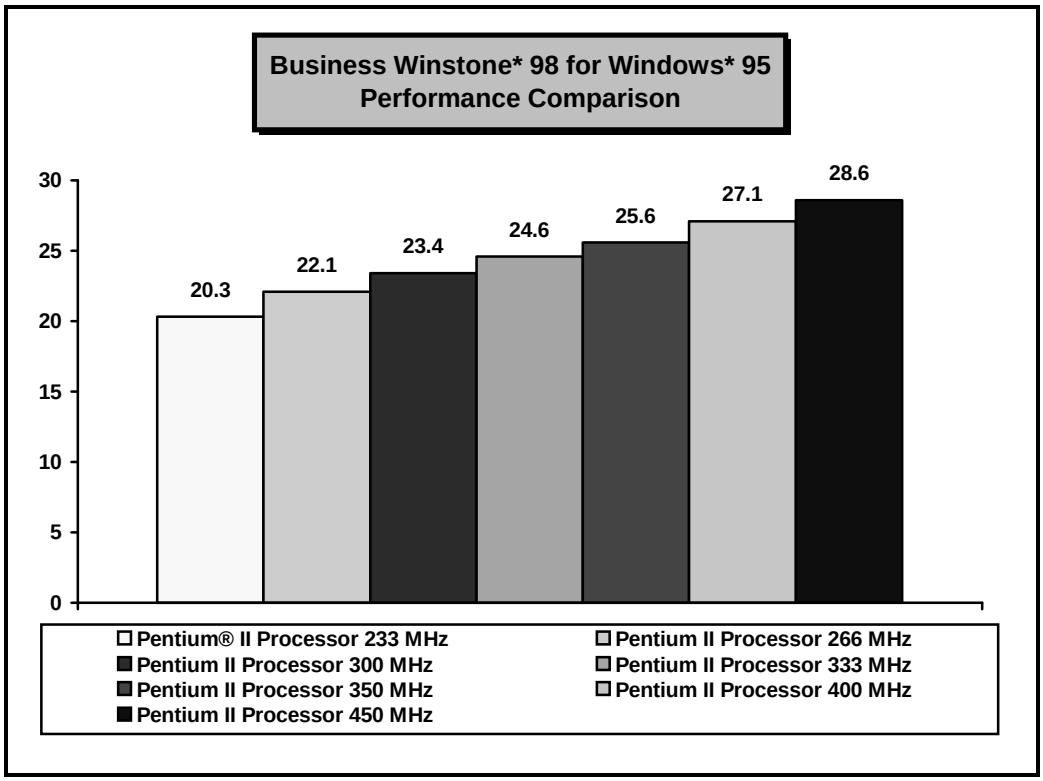

Figure 7. Intel® Pentium® II Processor Performance for Winstone* 98 Business for Windows* 95

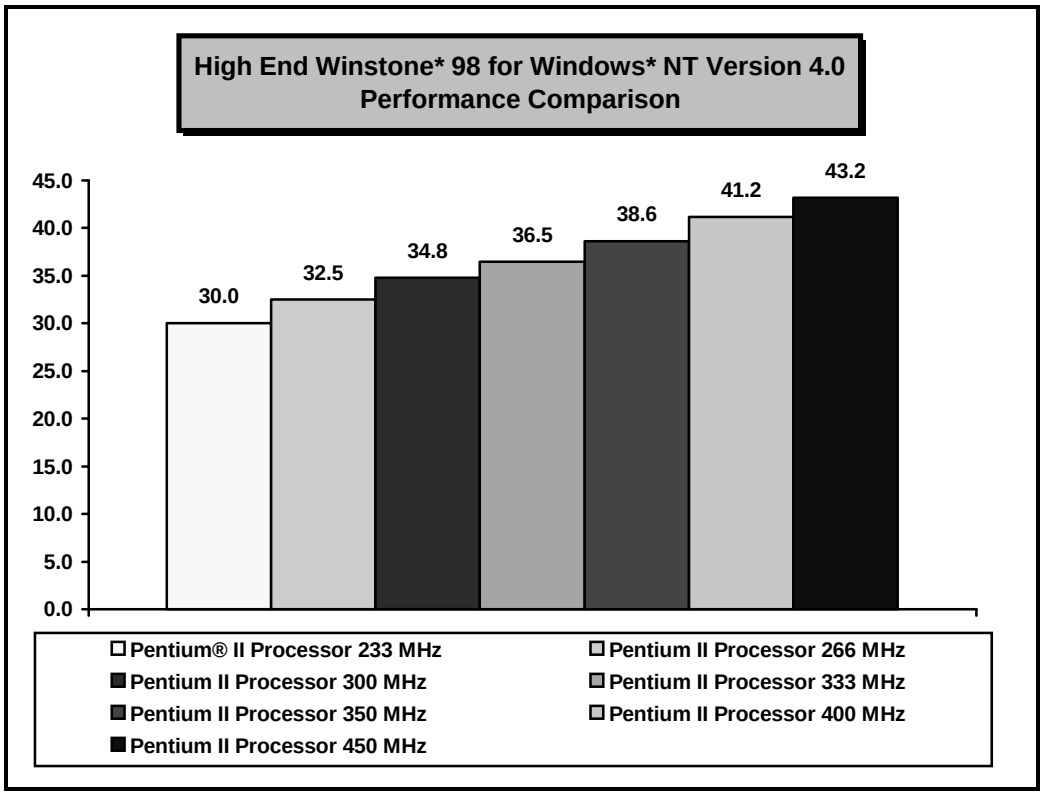

Figure 8. Intel® Pentium® II Processor Performance for Winstone* 98 High End for Windows* NT 4.0

Multimedia Benchmarks

Intel Media Benchmark

Multimedia applications are proliferating rapidly. Intel developed the Intel Media Benchmark at a time when an adequate industry standard multimedia benchmark did not exist to measure multimedia performance. The Intel Media Benchmark measures the performance of processors running algorithms found in multimedia applications. It incorporates audio and video playback, image processing, wave sample rate conversion, and 3D geometry.

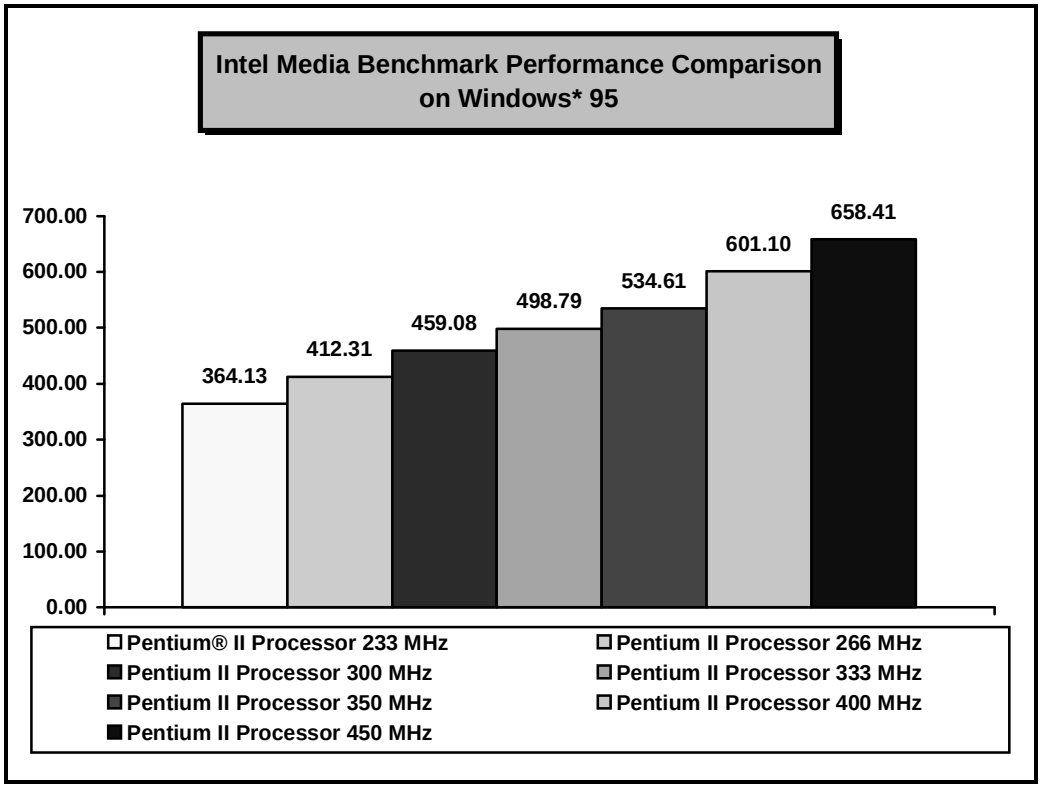

Figure 9. Intel® Pentium® II Processor Performance for the Intel Media Benchmark

Norton* Multimedia Benchmark

The Norton* Multimedia Benchmark, from Norton Utilities for Windows*95 Version 3.0, tests a system's multimedia capabilities and compares its performance to that of a system conforming to the basic Multimedia PC (MPC) Level 2 specification. The benchmark reports performance in five multimedia areas:

- Video - benchmarks video performance. It measures MPEG* video decompression and AVI video frame rates.
- 3D - tests rendering capabilities.
- Audio - measures audio mixing and MPEG* audio performance.
- CD-ROM - measures the CD-ROM drive's maximum seek and transfer rates.
- Imaging - tests image processing manipulations.

The Norton Multimedia Benchmark overall score shows a system's overall multimedia performance rating compared to a standard MPC2 system.

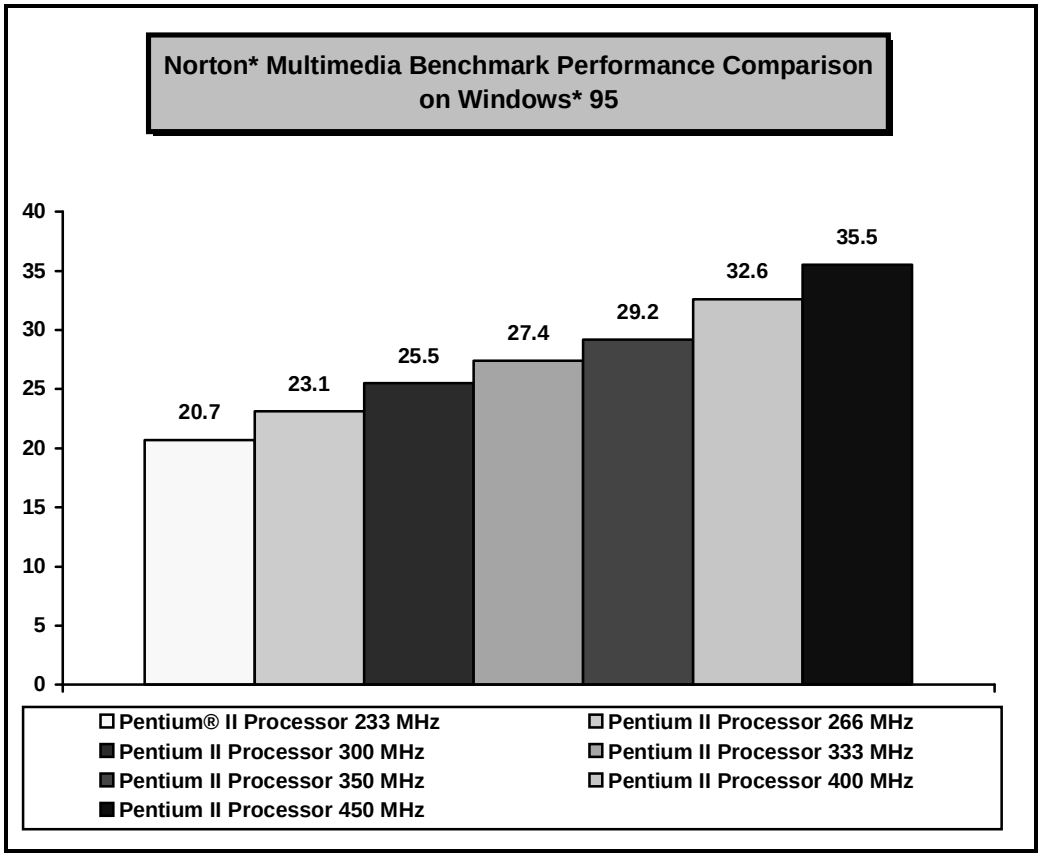

Figure 10. Intel® Pentium® II Processor Performance for the Norton* Multimedia Benchmark (See Table 4 for individual component scores from the benchmark)

Floating-Point Benchmarks

SPEC CPU*95 - SPECfp*95

SPEC CPU*95 is a software benchmark product which can be run on Windows* NT and many varieties of UNIX*. SPEC CPU 95 is produced by the Standard Performance Evaluation Corp. (SPEC), a non-profit group of computer vendors, system integrators, universities, research organizations, publishers, and consultants throughout the world. It was designed to provide measures of performance for comparing compute-intensive workloads on different computer systems.

The CFP*95 suite, written in the FORTRAN* programming language, contains ten CPU-intensive floating-point benchmarks. It is used to measure and calculate the following metrics:

- SPECfp*95 -- The geometric mean of 10 normalized ratios (one for each floating-point benchmark) when compiled with aggressive optimization for each benchmark.
- SPECfp_base*95 -- The geometric mean of 10 normalized ratios when compiled with conservative optimization for each benchmark.

For information on SPECint*95, please refer to the Integer Benchmark section of this document.

Figure 11 shows the SPECfp*95 performance on Windows*NT 4.0. See Appendix A for configuration details.

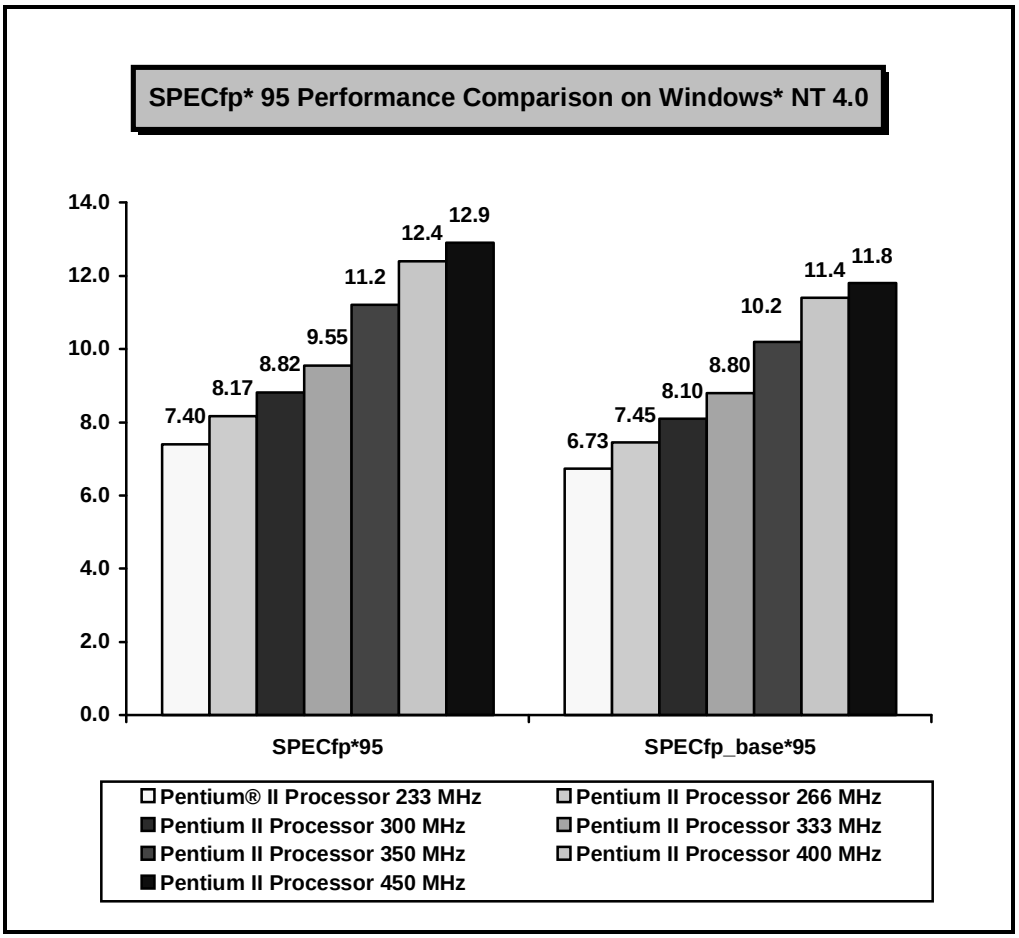

Figure 11. Intel® Pentium® II Processor Performance for the SPECfp*95 Benchmark on Windows* NT 4.0

The SPECfp*95 benchmark test provides a comparison point for the performance of the microprocessor, memory architecture, and compiler of a computer system on compute-intensive, 32-bit applications. SPEC benchmark test results for Intel microprocessors are determined using particular, well-configured systems. These results may or may not reflect the relative performance of Intel microprocessor in systems with different hardware or software designs or configurations (including compilers). Buyers should consult other sources of information, including system benchmarks, to evaluate the performance of systems they are considering purchasing. For more information about SPEC*95, including a description of the systems used to obtain these test result, and other information about microprocessor and system performance and benchmarks, visit Intel's World Wide Web site at www.intel.com or call 1-800-628-8686.

Norton* Multimedia Benchmark – 3D Graphics

The Norton* Multimedia Benchmark, from Norton Utilities for Windows*95 Version 3.0, tests a system's multimedia capabilities and compares its performance to that of a system conforming to the basic Multimedia PC (MPC) Level 2 specification. The 3D Graphics portion of Norton Multimedia Benchmark uses floating-point operations in its execution.

Figure 12 shows 3D Graphics performance.

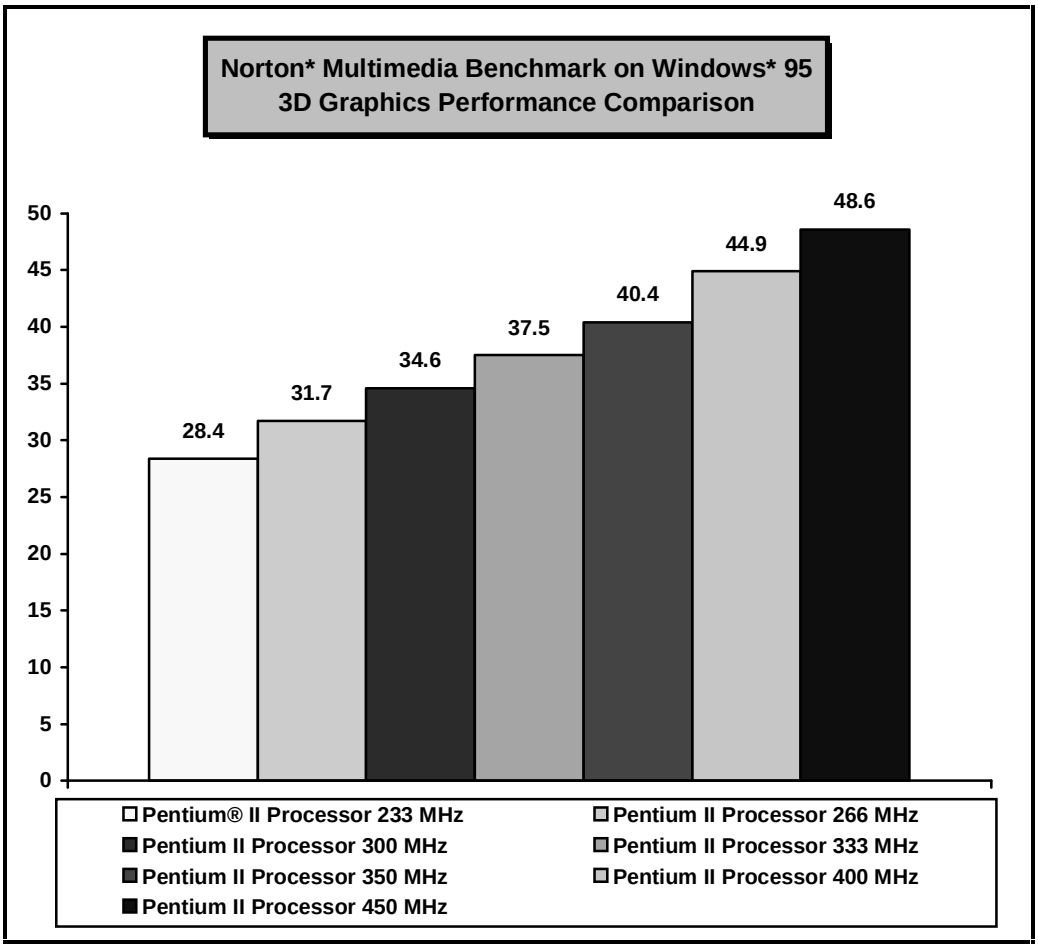

Figure 12. Intel® Pentium® II Processor Performance for the Norton* Media Benchmark – 3D Graphics

3D WinBench* 98

3D WinBench* 98, from Ziff-Davis*, measures the 3D performance of a computer system (including the microprocessor and the graphics card) using Microsoft's Direct3D* interface under Windows* 95. It includes a series of 19 tests that vary in complexity, the number of quality-enhancing options (such as fog, specular highlights, bilinear filtering and "mip-mapping") they employ, and the amount of texture they use. The processing includes 3D geometry calculations, which are floating-point intensive, and rasterization. Each test navigates through each scene using a predefined path and measures the rendering speed in frames per second. This suite returns an overall, unitless 3D WinMark* result summarizing the computer's performance on all tests.

Hardware acceleration is used when all quality-enhancing options for the given test are supported by the underlying hardware. Otherwise, software rasterization using MMX™ technology is employed if Microsoft's Direct3D* software rasterizer supports all the options for the test. If neither the graphics card nor the software rasterizer supports all the options, a score zero is granted.

The tests below have been run using the STB Velocity 128 AGP-based card. The benchmark was run without the anti-aliasing tests.

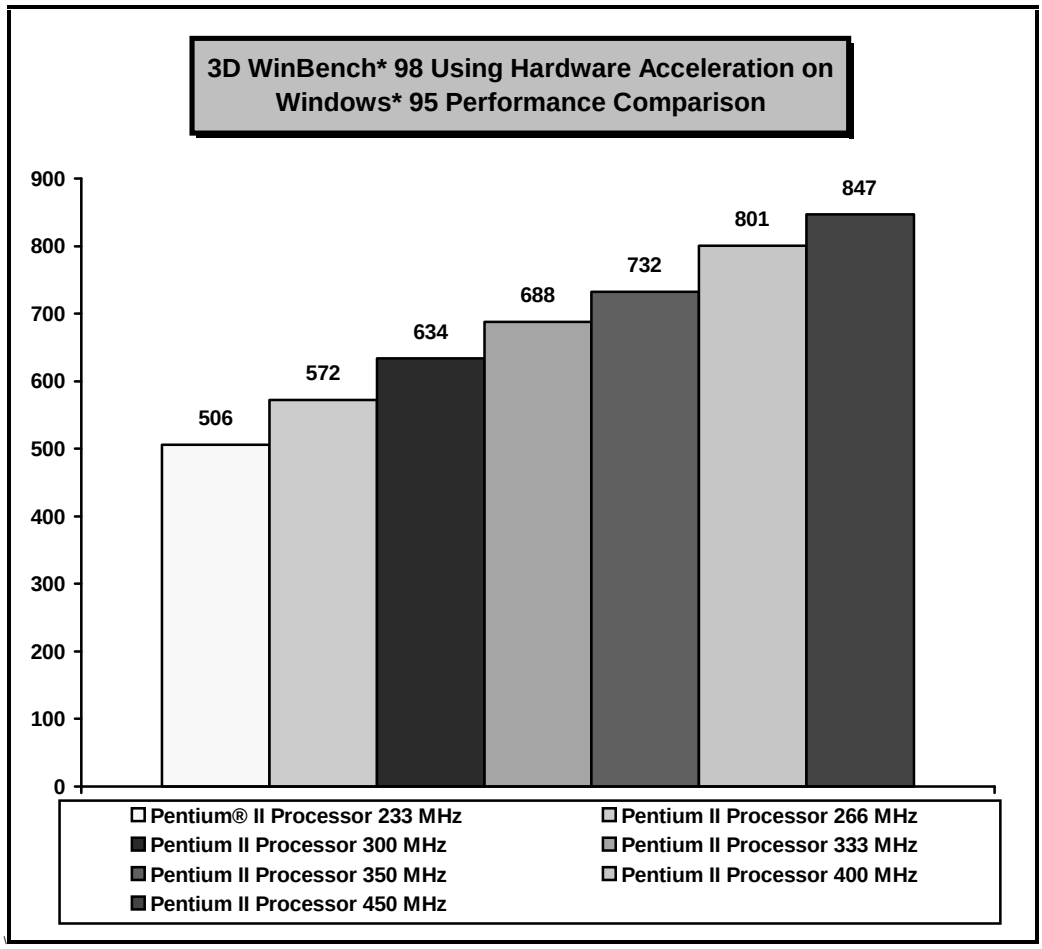

Figure 13. Intel® Pentium® II Processor Performance for the 3D WinBench* 98 (using hardware acceleration) Benchmark

FPU WinMark* Test

The FPU WinMark* Test measures the performance of the processor floating-point subsystem, which is used for such tasks as high-precision scientific calculations and complex graphics rendering. Developed by Ziff-Davis*, the test is synthetic. The test consists of five algorithms: 3D graphics operations, fast Fourier transforms (FFT), calculation of planetary orbitals, calculation of areas of polygons, and Gauss-Jordan elimination of coefficient matrix of linear equations. The algorithms were weighted by Ziff-Davis and are reported as one score.

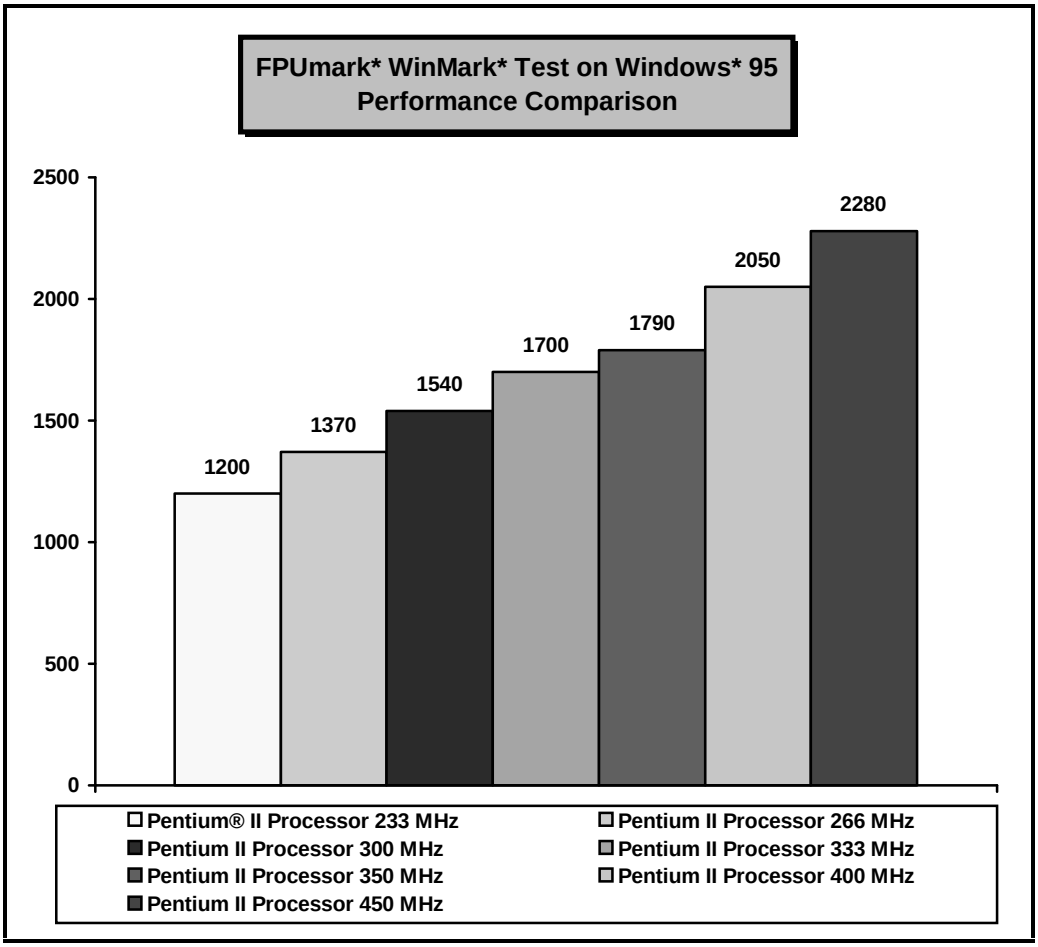

Figure 14. Intel® Pentium® II Processor Performance for FPUmark* WinMark* Test

SUMMARY

Table 1 summarizes the iCOMP® Index 2.0 performance for the Pentium® II processor family. (A higher score indicates better performance.)

Table 1. iCOMP® Index 2.0 Results

iCOMP® Index 2.0	Pentium® II Processor						
Processor Frequency	233 MHz	266 MHz	300 MHz	333 MHz	350 MHz	400 MHz	450 MHz
L2 Cache Size	512KB L2						
Rating	**267**	**303**	**332**	**366**	**386**	**440**	**483**

Tables 2 and 3 summarize the performance of benchmarks for the Integer Benchmark vector, both processor level and system level, for the Pentium® II processor family. (A higher score indicates better performance.)

Table 2. Three Vectors of Performance Benchmark Results – Integer Benchmarks – Processor Level

Processor	Pentium® II Processor						
Frequency - MHz	233/66	266/66	300/66	333/66	350/100	400/100	450/100
INTEGER BENCHMARKS							
Processor Level Benchmarks							
SPEC CPU*95/ Windows* NT 4.0							
SPECint*95	**9.38**	**10.70**	**11.90**	**13.00**	**13.90**	**15.80**	**17.2**
SPECint_base*95	9.38	10.70	11.90	13.00	13.90	15.80	17.2
Windows*							
Ziff-Davis* CPUmark*							
CPUmark*32	**604**	**690**	**769**	**850**	**895**	**1020**	**1120**
Norton* System Index*							
Norton* SI 32	**113.3**	**128.0**	**145.3**	**160.4**	**169.6**	**193.6**	**208.4**

Table 3. Three Vectors of Performance Benchmark Results – Integer Benchmarks – System Level

Processor	Pentium® II Processor						
Frequency - MHz	**233/66**	**266/66**	**300/66**	**333/66**	**350/100**	**400/100**	**450/100**
INTEGER BENCHMARKS							
System Level Benchmarks							
SYSmark*32/ Windows* 95	**257**	**284**	**312**	**332**	**346**	**384**	**410**
Publishing	236	259	283	297	317	349	370
Graphics	278	317	351	382	395	443	498
Presentation	263	289	318	338	357	395	429
Word Processing	248	274	301	320	325	355	371
Spreadsheet	260	290	321	341	358	405	439
Database	254	277	299	322	341	374	391
SYSmark*/NT/ Windows* NT 4.0	**234**	**261**	**288**	**309**	**331**	**368**	**394**
Spreadsheet	205	224	243	261	281	307	325
Project Management	305	341	384	404	427	481	513
Word Processing	205	227	248	268	284	310	325
Presentation	239	270	297	322	351	393	425
CAD	228	258	287	312	334	375	413
Winstone* 98 - Business/ Windows*95	**20.3**	**22.1**	**23.4**	**24.6**	**25.6**	**27.1**	**28.6**
Browsers	2.68	2.98	3.29	3.51	3.69	4.04	4.3
Publishing	2.28	2.51	2.73	2.89	2.98	3.22	3.47
Spreadsheet/ Database	1.61	1.72	1.77	1.83	1.90	1.96	2.03
Task Switching	1.29	1.33	1.36	1.39	1.40	1.44	1.47
Word Processing	2.17	2.37	2.54	2.7	2.82	3.02	3.22
Winstone* 98 - High End/ Windows NT 4.0	**30.0**	**32.5**	**34.8**	**36.5**	**38.6**	**41.2**	**43.2**
AVS/Express* 3.1	3.66	4.03	4.39	4.63	5.19	5.33	5.60
Microstation* 95	2.26	2.41	2.51	2.58	2.70	2.81	2.98
FrontPage* 97	2.96	3.27	3.54	3.77	3.95	4.30	4.53
Photoshop* 4.0	3.50	3.81	4.06	4.27	4.42	4.82	5.04
Adobe Premiere* 4.2	2.32	2.44	2.56	2.64	2.77	2.90	2.98
PV-wave* 6.1	3.46	3.86	4.25	4.59	4.98	5.54	5.95
Visual C++* 5.0	3.66	3.98	4.35	4.53	4.79	5.23	5.48

Table 4 summarizes the performance of benchmarks for the Multimedia Benchmark vector for the Pentium® II processor family. (A higher score indicates better performance.)

Table 4: Three Vectors of Performance Benchmark Results – Multimedia Benchmarks

Processor	Pentium® II Processor						
Frequency - MHz	**233/66**	**266/66**	**300/66**	**333/66**	**350/100**	**400/100**	**450/100**
Intel® Media Benchmark/ Windows* 95	**364.13**	**412.31**	**459.08**	**498.79**	**534.61**	**601.10**	**658.41**
Norton* Multimedia Benchmark from Norton Utilities for Windows* 95 Version 3.0	**20.7**	**23.1**	**25.5**	**27.4**	**29.2**	**32.6**	**35.5**
Video	13.0	14.7	16.3	17.3	18.0	20.3	22.4
3D Graphics	28.4	31.7	34.6	37.5	40.4	44.9	48.6
Audio	27.5	30.7	35.0	38.3	40.6	45.4	50
CD - ROM	8.8	8.9	8.9	8.5	8.9	8.9	8.9
Imaging	39.9	44.3	48.9	52.7	59.0	66.4	71.3

Table 5 summarizes the performance of benchmarks for the Floating-Point Benchmark vector for the Pentium® II processor family. (A higher score indicates better performance.)

Table 5: Three Vectors of Performance Benchmark Results – Floating-Point Benchmarks

Processor	Pentium® II Processor						
Frequency - MHz	**233/66**	**266/66**	**300/66**	**333/66**	**350/100**	**400/100**	**450/100**
SPEC CPU*95/ Windows* NT 4.0							
SPECfp_base*95	**6.73**	**7.45**	**8.10**	**8.80**	**10.2**	**11.4**	**11.8**
SPECfp*95	**7.40**	**8.17**	**8.82**	**9.55**	**11.2**	**12.4**	**12.9**
Norton* Multimedia Benchmark /3D Graphics	28.4	31.7	34.6	37.5	40.4	44.9	48.6
Ziff-Davis* 3D WinBench* 98							
3D WinBench* 98	**506**	**572**	**634**	**688**	**732**	**801**	**847**
Ziff-Davis *WinBench* 98							
FPUmark	**1200**	**1370**	**1540**	**1700**	**1790**	**2050**	**2280**

APPENDIX A — TEST CONFIGURATIONS

Windows* System Configuration

Processor	**Pentium® II Processor** **233, 266, 300, 333, 350, 400 and 450 MHz[1]**
System	Intel® 82440 BX AGPset based motherboard
FPU	Integrated
Primary Cache	32 KB (16KB I + 16 KB D)
Secondary Cache	512 KB WB with NO L2 ECC
Memory Size	Windows*95 - 32 MB SDRAM Windows* NT 4.0 - 64 MB SDRAM
Hard Disk Controller/Bus	Adaptec 2940UW* SCSI/PCI
Hard Disk	Seagate ST34501W*
Video Controller/Bus	For all benchmarks except 3D WinBench* 98: Matrox Millennium* II/AGP For 3D WinBench* 98: STB Velocity 128 AGP based Driver Version: v4.10.01.0230 with Microsoft DirectX *5.0
Video Memory Size/Type	Matrox Millennium* II - 4 MB SGRAM STB Velocity 128 – 4MB SGRAM
Operating System 1	**Windows* NT 4.0 with Service Pack 3**
Video Driver Revision	Matrox* v3.25
Graphics	For SYSmark*32 and SPEC CPU*95 - 1024x768 Resolution, 256 Color For Winstone* 98 - High End - 1024x768 Resolution, 16-bit Color
	SPEC CPU*95
C* Compiler	Intel C* Compiler 2.4 Plug In
FORTRAN* Compiler	Intel FORTRAN* Compiler 2.4 Plug In
Operating System 2	**Windows* 95 - Build 1212**
Video Driver Revision	Matrox* 3.7 with Microsoft DirectX* 5.0 STB Velocity 128: v4.10.01.0230 with Microsoft DirectX* 5.0
Graphics	All benchmarks except SYSmark* 32 – 1024x768 Resolution, 16-bit Color SYSmark*32 - 1024x768 Resolution, 256 color
	Audio - Media Benchmarks
CD ROM Drive	Toshiba* 32X CD ROM Model XM-6201B*
Sound Card	Creative Labs SoundBlaster* 16

1. Frequency set by replacing the processor and setting system jumpers as described in the system documentation.

APPENDIX B — ICOMP® INDEX CONFIGURATION

System Configuration used in iCOMP® Index 2.0 Ratings

Processor	**Pentium II Processor**[1]						
Frequency - MHz	**233/66**	**266/66**	**300/66**	**333/66**	**350/100**	**400/100**	**450/100**
FPU	Integrated						
System	Intel® 82440 FX PCIset based motherboard (Portland PD440FX)		Intel ®82440 LX AGPset based motherboard (Atlanta AL440LX)		Intel® 82440 BX AGPset based motherboard (Seattle SE440BX)		
Primary Cache	32 KB (16KB I + 16 KB D)						
Secondary Cache	512K WB		512K WB with ECC				
Hard Disk	Quantum Fireball* EIDE with Integrated EIDE disk controller						
Video	Matrox Millennium* PCI						
Audio	Creative Labs Sound Blaster* 16						
Operating System	**UnixWare* 2.0**						
Memory Size	64MB SDRAM						
C* Compiler	Intel C* Ref. Compiler 2.3						
FORTRAN* Compiler	Intel FORTRAN * Ref. Compiler 2.3						
Operating System	**Windows*95**						
Memory Size	32 MB SDRAM						
Graphics	All benchmarks except Intel Media Benchmark - 1024x768 Resolution, 256 Colors Intel Media Benchmark - 1024x768 Resolution, 16-bit color						

[1.] Frequency set by replacing the processor and setting system jumpers as described in the system documentation.

iCOMP® Index 2.0 Component Scores As Measured On Appendix B Configurations

Table 6: iCOMP® Index 2.0 Component scores on Appendix B Configurations

Processor	Pentium® II Processor						
Frequency - MHz	233/66	266/66	300/66	333/66	350/100	400/100	450/100
iCOMP® Index 2.0 Rating	267	303	332	366	386	440	483
CPUmark*32	606	693	746	832	870	996	1090
Norton SI*32	112.6	127.3	141.3	156.5	165.7	187.0	202.5
Intel Media Benchmark	310.25	351.10	387.92	423.48	442.04	500.51	557.26
SPECint_base*95	9.49	10.80	11.70	12.8	13.5	15.4	17.2
SPECfp_base*95	5.91	6.43	7.45	8.32	9.64	10.8	11.3

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