Mobile Pentium® Processor with MMX™ Technology Performance Brief

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INTRODUCTION

The Intel mobile Pentium® processor family provides outstanding performance for all mobile applications. The mobile Pentium processor with MMX™ technology enables new levels of multimedia and communications performance and is the highest performing Pentium processor. The mobile Pentium processor family consists of the following products:

- Pentium® processor with MMX ™ technology at 166 MHz
- Pentium processor with MMX technology at 150 MHz
- Pentium processor at 150 MHz
- Pentium processor at 133 MHz
- Pentium processor at 120 MHz
- Pentium processor at 100 MHz
- Pentium processor at 90 MHz
- Pentium processor at 75 MHz

This report provides test results of common benchmarks which illustrate the mobile Pentium processor with MMX technology performance beginning with the Pentium processor at 150 MHz. Details of the system configurations used in all the benchmarks throughout this brief are described in Appendix A.

Modern industry standard benchmarks were chosen to demonstrate the performance of the mobile Pentium processor family. Robust benchmark programs should be representative of how well the actual applications will execute. However, performance is often the combined characteristics of a given computer architecture and many other tightly coupled system software/hardware constituents rather than just the CPU. Operating system, compilers, libraries, memory design and I/O subsystem characteristics may well dominate the results and make comparisons difficult.

As operating systems and applications have moved towards a 32-bit environment, they require system vendors and users to be cognizant of 32-bit workload performance. As such, most product planning and purchasing decisions are expected to be based on 32-bit benchmarks in order to ensure that these decisions are relevant for the entire life of a system. Intel is committed to using the most robust and relevant benchmarks in characterizing its products' performance and thus this report focuses on 32-bit metrics. However, a 16-bit metric is included for reference purposes.

THE INTEL PENTIUM® PROCESSOR WITH MMX™ TECHNOLOGY

The Intel Pentium processor with MMX technology delivers excellent performance for all PC software. It is fully compatible with the huge base of PC software. Additionally, the Pentium processor with MMX technology enables new levels of multimedia and communication performance. It has immediate responsiveness for the latest, most demanding software with powerful realistic graphics and the ability to run full-screen, full-motion video.

MOBILE PENTIUM® PROCESSOR WITH MMX™ TECHNOLOGY PRODUCT FEATURE HIGHLIGHTS

Such dramatic performance allows the mobile Pentium processor with MMX technology to run today's most demanding mobile applications. It has the performance to run full-screen, full-motion video, real-time animation, compute intensive 3D modeling graphic applications, and mobile multimedia presentations.

The mobile Pentium processor with MMX technology is fully compatible with an entire library of mobile applications based on operating systems such as MS-DOS*, Windows 3.1*, Windows 95*, OS/2*, UnixWare*, SCO UNIX*, Windows NT*, OPENSTEP*, and Sun Solaris*. It has several features which allow high-performance notebooks to be designed, including the following:

- 150 and 166 MHz
- New instructions that accelerate multimedia and communications performance
- 32KB Level One Cache
- Separate Code and Data Caches with MESI Protocol
- Pin Compatible with previous Pentium processors
- Improved Branch Prediction
- Superscalar Architecture
- More efficient instruction decoder
- Floating Point Unit
- 64-bit External Data Bus
- Performance Monitoring and Execution Tracing
- High-Reliability Error Detection
- Voltage Reduction Technology of 2.45V core supply and 3.3V I/O buffer supply

iCOMP® INDEX

The iCOMP® (Intel Comparative Microprocessor Performance) 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. Intel has updated the iCOMP Index to version 2.0. There are three major market and performance trends that have influenced the latest formula adjustment:

1. The development of benchmarks appropriate for emerging popular application profiles
2. The accelerating transition to 32-bit operating systems and applications on the desktop
3. The proliferation of multimedia, communications and 3D

The iCOMP Index 2.0 ratings cannot be compared with the earlier version of iCOMP because different benchmarks are 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 components: Audio, Imaging, Video and 3-D (see Intel Media Benchmark section below). Each category and subcategory is weighted based on the estimated percentage of time it enters into the processing picture. The higher the iCOMP rating, the higher the relative performance of the microprocessor. Each processor's iCOMP Index rating is calculated at the time that processor is introduced except that ratings for processors introduced before iCOMP Index 2.0 were calculated when version 2.0 was released. Four standard benchmarks are used for 2.0 ($CPUmark_{32}$*, Norton SI32*, SPECint95, SPECfp95) as well as the Intel Media Benchmark. Differences in system design (including software) and configuration will affect actual performance.

Figure 1 illustrates the iCOMP 2.0 ratings for three Intel microprocessors, as run on desktop systems. The Intel Pentium processor with MMX technology at 166 MHz has an iCOMP 2.0 rating of 160. System configurations used in iCOMP Index 2.0 measurements are listed in Appendix B. For more information on iCOMP Index 2.0, contact Intel Corporation or visit Intel's web site at http://www.intel.com.

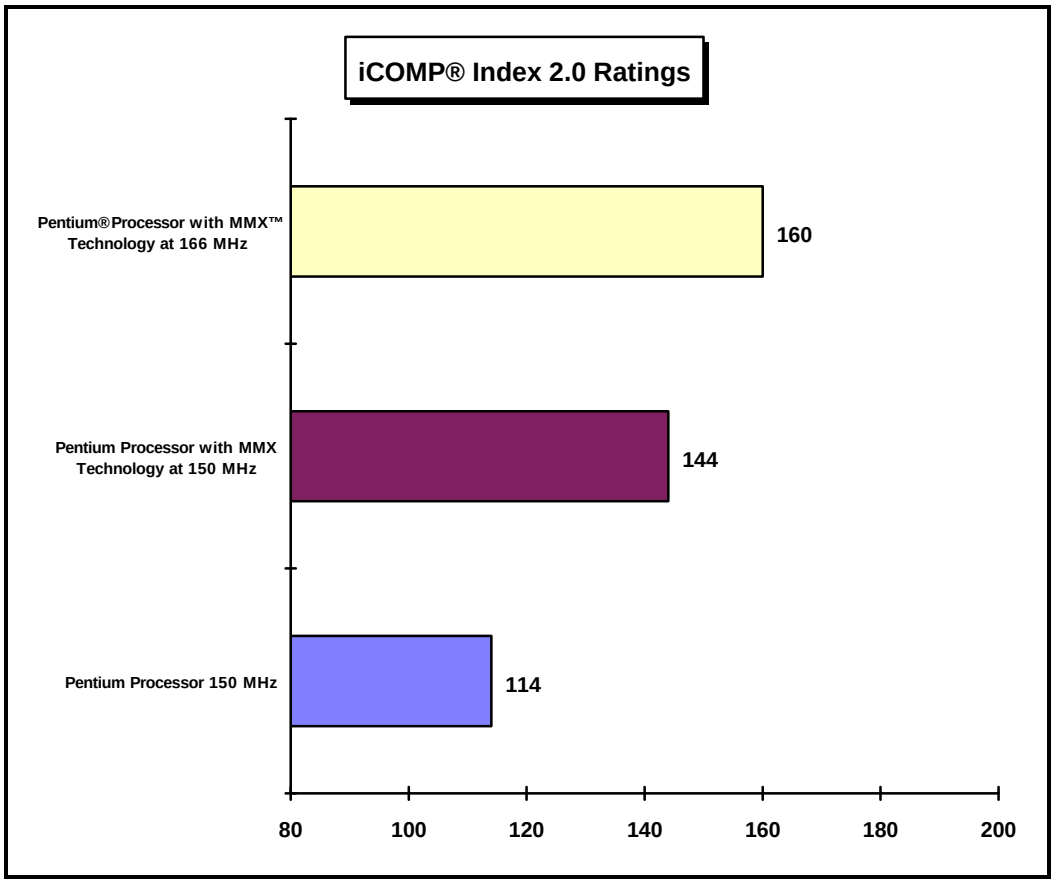

Figure 1. iCOMP® Index 2.0 Ratings for Intel Processors

Intel Media Benchmark

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

The most probable anticipated use of the microprocessor in video applications will be to provide software decompression of video data. One algorithm, which is increasing in popularity, is the industry standard MPEG1 algorithm, such as that used by the popular Xing Technology decompression and the Berkeley MPEG1 shareware software. The video playback component of the Intel Media Benchmark implements the MPEG1 decompression algorithm (ISO11172-2). This benchmark focuses on the contribution of the processor in implementing a video player.

The audio component is based on the MPEG1 audio decompression definition (ISO11172-3). This component of the Intel Media Benchmark decompresses and plays a stereo audio clip. The audio component also includes sample rate conversion, special effects and stereo mixing.

The image processing component applies digital filters to true-color (24-bit) bitmap images. These filters include a box filter which is used to implement filters such as Gaussian blur and embossing, an image blending function used to combine two images into one, and a color space conversion function used to change an image's luminance.

The 3D component of the Intel Media Benchmark is based on Direct3D* and a geometry routine from the OpenGL* 3D Triangle benchmark. These tests are used to measure the geometry portion of a 3D workload. As such, rasterization performance is not measured. It is Intel's belief that in the next two to three years rasterization will be encompassed by the graphic accelerator card. Thus the performance of rasterization will not be CPU bound and is therefore not measured with regard to the processor performance. However, it is anticipated that 3D geometry will remain the duty of the processor.

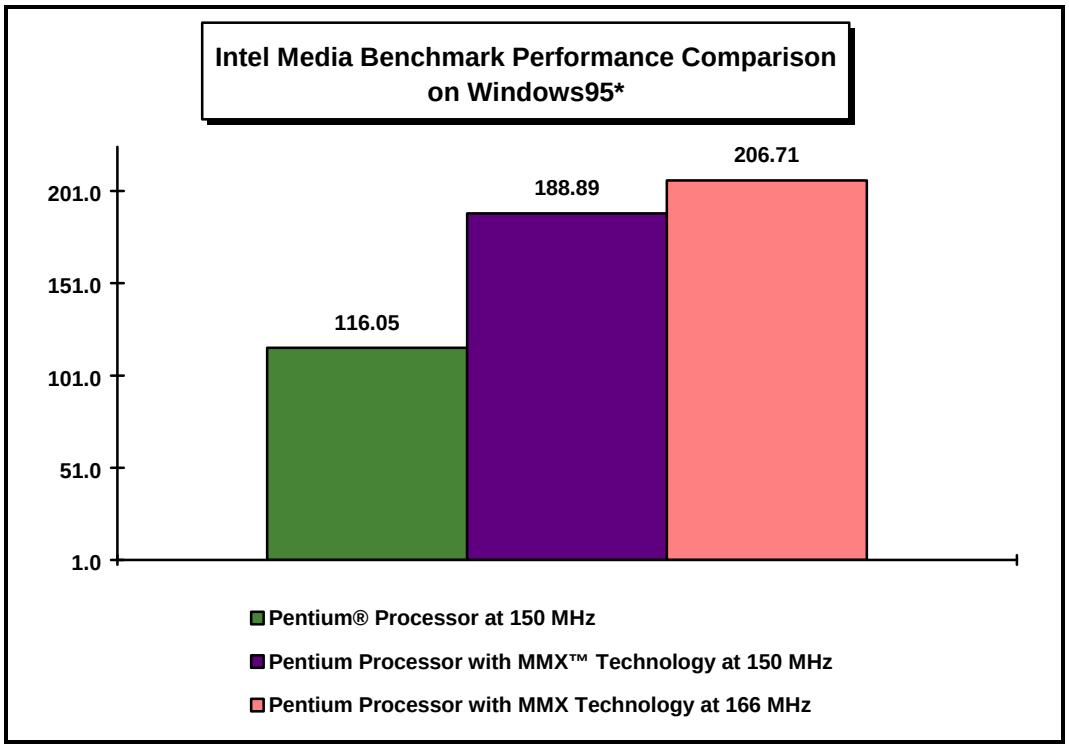

Figure 2. Mobile Pentium ® Processor Performance for the Intel Media Benchmark

MICROPROCESSOR PERFORMANCE SUMMARY

MS-DOS*/Windows* Processor Benchmarks

32-BIT/16-BIT CPU

The 32-bit integer Windows performance of the Pentium processor is illustrated by the commonly used Windows benchmarks presented. These benchmarks represent the high performance potential achieved with the Intel Pentium processor for running 32-bit applications.

$CPUmark_{32}$* is a 32-bit Windows processor benchmark provided by Ziff-Davis Labs designed to measure the performance potential for running future 32-bit applications. $CPUmark_{16}$* is the 16-bit equivalent.

Norton SI32* is a 32-bit Windows 95 benchmark designed to show the speed of a system (CPU, L2 cache, and memory), compared to the speed of other systems for running common 32-bit applications. This benchmark is part of the SYSINFO* module of the Norton Utilities* for Windows 95.

Figures 3 and 5 illustrate the Intel Pentium processor performance when executing these two popular 32-bit benchmarks. Figure 4 shows the 16-bit performance.

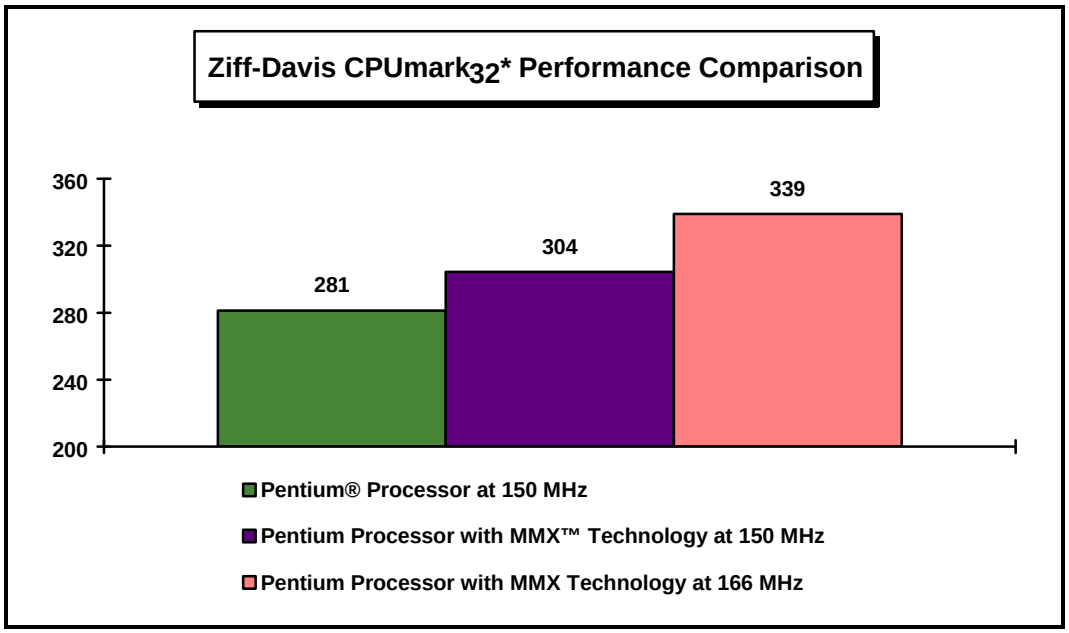

Figure 3. Mobile Pentium ® Processor Performance for the Ziff-Davis $CPUmark_{32}$* Benchmark

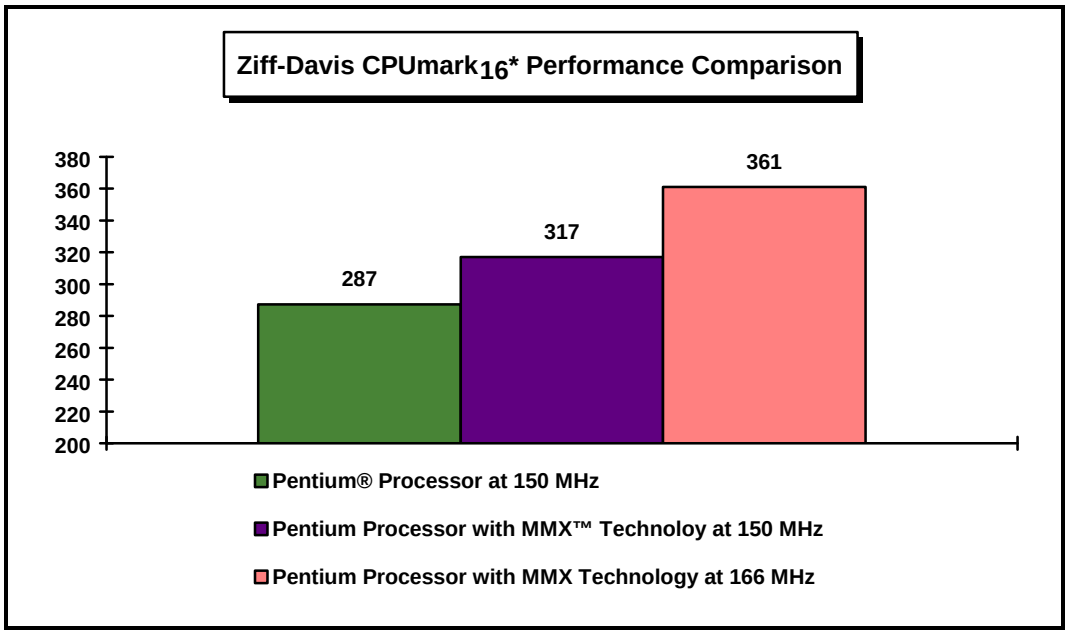

Figure 4. Mobile Pentium ® Processor Performance for the Ziff-Davis CPUmark $_{16}$* Benchmark

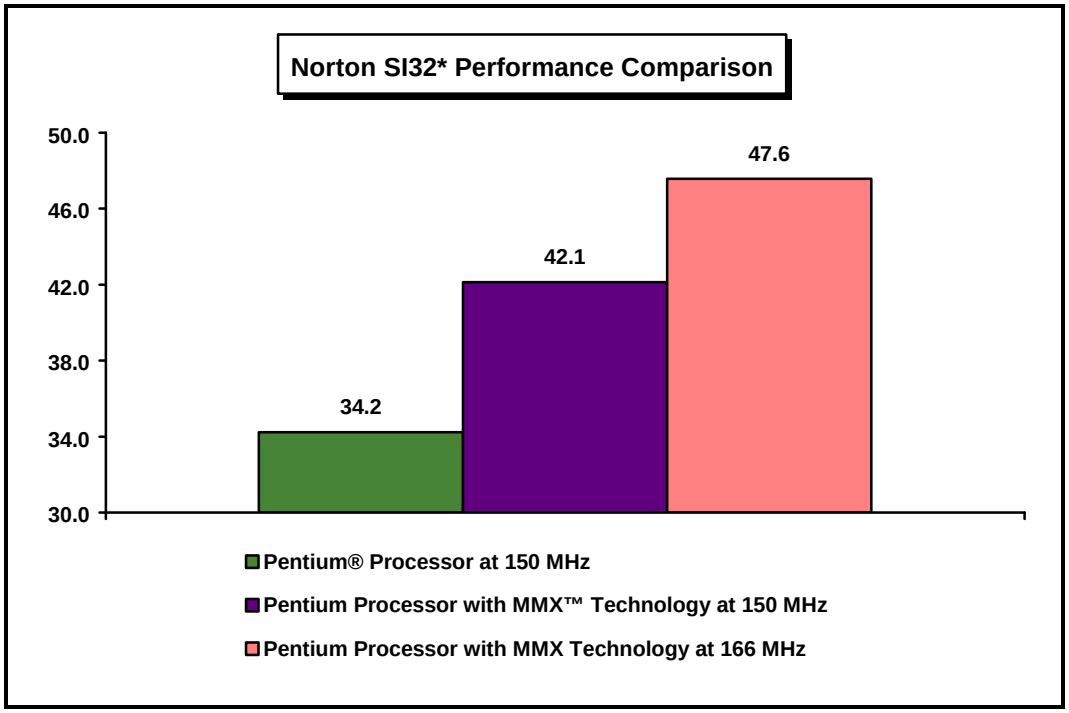

Figure 5. Mobile Pentium ® Processor Performance for the Norton SI32* Benchmark

SUMMARY

Table 1 summarizes the microprocessor benchmark performance results for the mobile Pentium processors discussed in this performance brief. (The higher the number, the better the performance). The iCOMP Index 2.0 rating is also given.

Table 1. Mobile Pentium® Processor Benchmark Results

Processor Benchmarks	Pentium® Processor 150 MHz	Pentium Processor with MMX™ Technology 150 MHz	Pentium Processor with MMX Technology 166 MHz
Intel Media Benchmark	**116.05**	**188.89**	**206.71**
Norton System Index*			
SI32*	34.23	42.13	47.57
Ziff-Davis CPUmark			
$CPUmark_{16}$*	287.33	317.00	361.00
$CPUmark_{32}$*	281.33	304.33	339.00
iCOMP® Index 2.0 Rating	**114**	**144**	**160**

APPENDIX A — TEST CONFIGURATIONS

System Configuration for Pentium® Processors at 150 MHz and Pentium Processors with MMX™ Technology at 150 and 166 MHz

Processor	**Pentium® Processor- 150 MHz**	**Pentium Processor with MMX™ Technology - 150, 166 MHz**
Board	Intel Titus Eval board	
FPU	Integrated	
Primary Cache	8-Kbyte (Instruction) 8-Kbyte (Data)	16-Kbyte (Instruction) 16-Kbyte (Data)
Secondary Cache	256 KB Synchronous Burst Pipelined	
Memory Size/Speed	16 MB EDO DRAM/60ns	
Motherboard Chip Set	Intel 82430 MX PCIset	
BIOS	Pheonix* V4.04 (non-production version)	
Hard Disk	Quantum Europa* 810 MB (14 ms)	
Operating System	Windows 95*	
Video Controller/Bus	Chips & Technology* 65550/PCI	
Video Memory Size	1 MB	
Graphics	800 x 600 Resolution, 256 Colors	

APPENDIX B — iCOMP® INDEX CONFIGURATION AND INTEL MEDIA BENCHMARK INFORMATION

System Configuration Used in iCOMP® Index 2.0 Ratings

CPU	Pentium® Processor at 133 MHz, 150 MHz, 166 MHz and 200 MHz	Pentium Processor with MMX™ Technology at 166 MHz and 200 MHz
FPU	Integrated	
System	Dell Dimension* XPS 133c (modified)	Dell Dimension* XPS 166s (modified)
Primary Cache	16 KB (8 KB I + 8 KB D) for all other Pentium processors	32 KB (16 KB I + 16 KB D) for Pentium processor with MMX technology
Secondary Cache	512K WB Burst	
Hard Disk	Quantum Fireball* EIDE with Integrated EIDE disk controller	
Video	Matrox Millennium* PCI	
Audio	Creative Labs Sound Blaster* 16	
For SPEC95:		
Memory Size	64 MB EDO	
Operating System	UnixWare* 2.0	
C Compiler	Intel C Ref. Compiler 2.3	
FORTRAN Compiler	Intel FORTRAN Ref. Compiler 2.3	
For all other benchmarks:		
Memory Size	32 MB EDO	
Operating System	Windows 95*	
Graphics	All benchmarks except Intel Media Benchmark - 1024x768 Resolution, 256 Colors Intel Media Benchmark - 1024x768 Resolution, 16-bit color	