THE TOLLY GROUP

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Intel® Corporation

Ultra Low Voltage Intel® Celeron® M CPU at 600 MHz with 512 KB Level 2 Cache

TOLLY Up to Spec CERTIFIED Test Summary

Competitive Performance Evaluation versus AMD Geode™ 500 MHz with 128 KB Level 2 Cache, VIA C7 "Esther" 1.5 GHz with 128 KB Level 2 Cache

Premise: *Architects of PC and embedded systems need to know the comparative CPU performance and memory access characteristics of various "motherboards" that they are considering as base platforms in order to make an informed decision as to the relative value propositions of competing products and vendors. Standard benchmarks provide this required information.*

Intel Corporation commissioned The Tolly Group to benchmark the performance of its Ultra Low Voltage Intel® Celeron® M processor operating at 600 MHz and equipped with a 512 KB Level 2 cache alongside two other similar products: The VIA Technologies EPIA EN15000 mainboard (containing a VIA C7 "Esther" 1.5 GHz processor with a 128 KB Level 2 cache) and the AMD Geode™ LX DB800 development board (operating at 500MHz with a 128KB Level 2 cache).

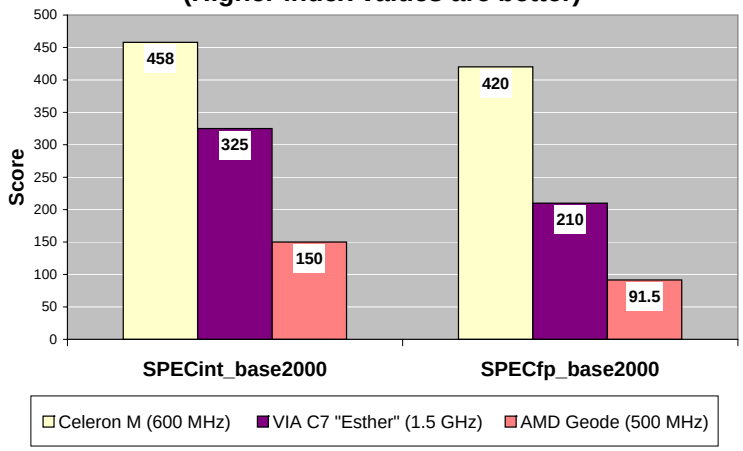
Tolly Group engineers subjected all three systems to a battery of benchmark tests exercising the full range of capabilities of the devices. Performance comparisons were drawn from the devices that were subjected to industry-standard benchmarks utilizing the SPEC CPU2000 v1.3 from Standard Performance Evaluation Corporation, PCMark05 Professional from Futuremark Corp. and SANDRA 2007 Professional from SiSoftware Ltd.

Tests were conducted at The Tolly Group's research facility in Boca Raton, FL during July through August 2006.

Test Highlights

- Outperforms VIA Technologies C7 and AMD Geode processors in SPEC CPU2000 integer and floating point tests
- Surpasses the AMD Geode and VIA Technologies C7 processors in system, memory and CPU performance during PCMark05 tests
- Delivers superior performance compared to VIA Technologies C7 and AMD Geode processors during SANDRA 2007 memory bandwidth benchmark tests
- Delivers up to 57% and 22% the performance over the AMD Geode and VIA Technologies C7 processors respectively in SANDRA 2007 cache and memory access benchmark

Comparison of CPU Performance Benchmark — SPEC CPU2000
(Higher index values are better)



Note: AMD does not support the necessary SSE CPU instructions to properly run the SPEC CPU2000 System Test Suite Benchmark.

Source: The Tolly Group, September 2006 *Figure 1*

Executive Summary

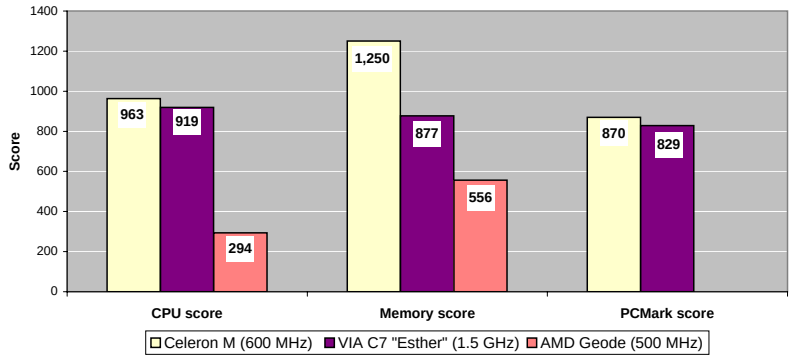
The Ultra Low Voltage Intel® Celeron® M processor delivered consistently better CPU performance when benchmarked against two rival products.

Benchmark tests conducted by The Tolly Group reveal that the Ultra Low Voltage Intel® Celeron® M processor operating at 600 MHz consistently outperformed the competitive products tested using industry-standard benchmark tools, demonstrating that Intel delivers greater performance in CPU, memory and system.

SPEC CPU2000 Benchmark

Engineers utilized SPEC CPU2000 ver. 1.3. With respect to both the compute-intensive integer and floating-point performance, the Ultra Low Voltage Intel® Celeron® M processor at 600 MHz generated the maximum scores with values of 458 and 420 respectively for both tests. (See Figure 1). The VIA Technologies C7 1.5 GHz and the AMD Geode 500-MHz processors both received lower scores of 325 and 150, respectively, in the integer testing using SPECint_base2000. For the floating-point testing (SPECfp_base2000), the AMD Geode and the VIA Technologies C7 "Esther" processors achieved scores of 91.5 and 210, respectively. *(For a greater explanation of speed factor, see the SPEC CPU2000 section in the Test Methodology section of this report.)*

Comparison of CPU Performance Benchmark — PCMark05
(Higher index values are better)



Note: AMD does not support the necessary SSE CPU instructions to properly run the PCMark system Test Suite Benchmark.

Source: The Tolly Group, September 2006

Figure 2

PCMark05 Benchmark

Engineers conducted all the tests included in the System, CPU and Memory Test Suites of PCMark05 on the three devices under test. Tests were conducted with PCMark05 Professional version 1.1.0. The best performance for this benchmark was observed with the 600-MHz Ultra Low Voltage Intel® Celeron® M processor, which delivered a top Memory score of 1,250 — or 56% greater than the 500-MHz AMD Geode; while the the Ultra Low Voltage Intel® Celeron® M processor outperformed the VIA C7 "Esther" 1.5-GHz processor y 30%. (See Figure 2.)

CPU performance scores clearly favored the Ultra Low Voltage Intel® Celeron® M processor, which delivered an average score of 963, versus scores of 919 for the VIA Technologies C7 "Esther" processor a a low of 294 for the AMD Geode.

For the PCMark scores gathered from the System Test Suite, again the Ultra Low Voltage Intel® Celeron® M processor delivered superior performance over the VIA Technologies C7 "Esther" processor with an average score of 870 versus 829, respectively. The AMD Geode was not able to run the System Test Suite from PCMark05 due to the lack of hardware support to SSE CPU instructions set to run properly the PCMark System Test Suite benchmark.

SANDRA 2007 Benchmark

Engineers conducted tests in two areas: "memory bandwidth" and "cache and memory access." Tests were conducted using SANDRA 2007 Professional Business version 2007.5.10.98.

In the SANDRA memory bandwidth benchmarks, the Ultra Low Voltage Intel® Celeron® M processor at 600 MHz led all devices again for both the integer-based and floating point-based memory benchmarks, delivering up to 3.5X greater floating-point performance than the 500-MHz AMD Geode processor and up to 2X better performance than the 1.5-GHz VIA Technologies C7 "Esther" processor. (See Figure 3.)

In the cache and memory access benchmark, the Ultra Low Voltage Intel® Celeron® M processor

outperforms the 500-MHz AMD Geode processor and the VIA Technologies C7 "Esther" processor by as much as 57% and 22% with a score of 2,399 MB/s versus 1,031 MB/s and 1,882 MB/s, respectively. (See Figure 4.)

Analysis

Test results show that processor clock speed, alone, is not a proven arbiter of overall performance. The Ultra Low Voltage Intel® Celeron® M processor at 600 MHz consistently delivers greater performance across the SPEC CPU2000, PCMark05 and SANDRA 2007 tests than other devices tested.

From the results of the SPEC CPU2000 suite benchmarks executed on the Ultra Low Voltage Intel® Celeron® M processor, the AMD Geode and the VIA Technologies C7 "Esther" processors, it is evident that the Ultra Low Voltage Intel® Celeron® M device performed better in integer-based and floating point-based benchmarks than the VIA Technologies and AMD devices.

The reason could be attributed to platform-based features of these devices, especially caching capabilities. Benchmark scores are always disputable, as they are based upon simulated workloads, and seldom on real workloads. Therefore, the actual performance of the processors should be assessed based on real applications and the benchmarks should be a guideline to make a performance comparison.

In the PCMark05 tests, the Ultra Low Voltage Intel® Celeron® M processor at 600 MHz outperformed all other processors – in system, CPU and memory score tests. Such extra performance headroom assures developers the processor can accommodate surges in load without jeopardizing system design.

The results of memory bandwidth and the cache and memory access benchmarks from SANDRA 2007, the Ultra Low Voltage Intel® Celeron® M processor at 600 MHz again bested both rival processors in integer-based and floating point-based benchmarks.

Related Tests

Intel commissioned The Tolly Group in November-December 2004 to benchmark the performance of its Ultra Low Voltage Intel® Celeron® processors operating at 600 MHz alongside three VIA Technologies processors: a 1-GHz VIA C3 "Nehemiah" with 64 KB Level 2 cache, a 933-MHz VIA C3 "Ezra-T" with 64 KB Level 2 cache and a 600-MHz VIA C3 "Samuel2" with 64 KB Level 2 cache.

Engineers subjected all four devices to a battery of benchmark tests exercising their full range of capabilities. Performance comparisons were drawn from the devices that were subjected to industry-standard tests utilizing the PCMark04, WebMark 2004 and SYSmark 2004 (Futuremark Corp.), SANDRA 2004 (SiSoftware Ltd.) and SPEC CPU2000 V1.2 (Standard Performance Evaluation Corp.) benchmarks.

For more information or to access the Test Summary report, go to: http://www.tolly.com/DocDetail.aspx?DocNumber=205107

Test Configuration and Methodology

For performance tests, The Tolly Group tested the Ultra Low Voltage Intel® Celeron® M processor at 600 MHz, a device outfitted with 64 KB of Level 1 cache memory, 512 KB of Level 2 cache memory and 512 MB PC2100 RAM.

The Tolly Group tested the Ultra Low Voltage Intel® Celeron® M device against a VIA Technologies EPIA EN15000 mainboard with a VIA Technologies C7 "Esther" embedded processor operating at 1.5 GHz, as well as, an AMD Geode LXDB800 Development Board with an embedded processor

Intel Corp.

Intel® Celeron® M Processor at 600 MHz with 512K Level 2 Cache

CPU Performance Evaluation

Intel Corporation
Intel® Celeron® M Processor at 600 MHz with 512 KB Level 2 Cache
Product Specifications*
Vendor-supplied information not necessarily verified by The Tolly Group

Feature
- Core speed: 600 MHz
- Front-side bus speed: 400 MHz
- Level 2 cache: 512 KB
- Thermal design power: 7.0W
- VID: 1.004V
- Package: 479 µFC-BGA
- Product number: RJ80535VC600512

Feature
- Validated with Intel® 852GME chipset
  - 400 MHz or 533 MHz system bus
  - DDR 266/333
  - Integrated graphics using Intel® Extreme Graphics 2 technology
  - Package: 732 µFC-BGA
  - Product number: RG82852GME
- Validated with Intel® ICH4 I/O controller hub
  - Six (6) USB ports with USB 2.0 support
  - Integrated LAN interconnect interface
  - Package: 421 micro-BGA
  - Product number: FW82801DB

For more information contact:
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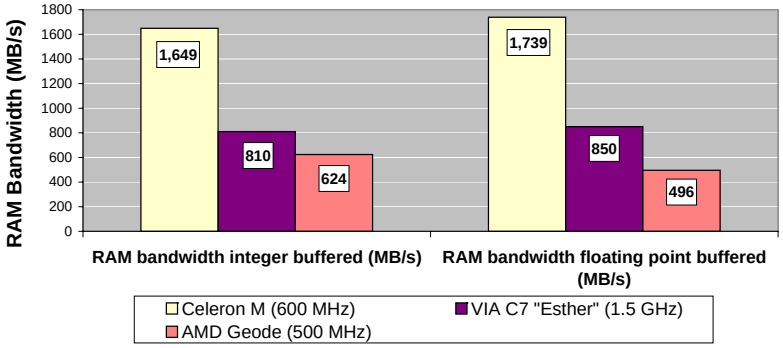
URL: http://www.intel.com



Note: Intel and VIA Technologies support the iSSE2 instructions set, while AMD supports SSE1 instructions.

Source: The Tolly Group, September 2006 *Figure 3*

running at 500 MHz. The 1.5 GHz VIA Technologies device was outfitted with 64 KB of Level 1 cache memory, 128 KB of Level 2 cache memory and 512 MB PC3200 RAM. The 500-MHz AMD Geode device was outfitted with 64 KB Level 1 cache memory, 128 KB Level 2 cache memory and 512 PC2700 MB RAM.

All devices were housed with a 250-watt ATX form factor power supply, a 60-Gbyte Maxtor ATA 7200 RPM hard drive, Rosewill 52x24x52/16x Combo Drive (CD-RW & DVD-ROM), Intel® C++ Compiler 9.1 for Windows, Intel® Visual Fortran 9.1 Compiler for Windows, Microsoft Visual Studio .NET 2002 Enterprise Architect Edition and Microsoft Windows XP Professional with Service Pack 2.

Each device was set with a stable configuration in order to avoid any benchmark failures during each run. For video display settings, engineers configured the color quality and screen resolution to medium (16-bit) and 1024x768 pixels, respectively. For visual effects, engineers set each device with "Adjust for best performance" option. For virtual memory configuration, engineers set a memory range from 672 MB to 1,344 MB. Lastly, engineers disabled the following services from the operating system in order to reduce the number of processes running in the background: Automatic Updates, Security Center, and Wireless Zero Configuration.

Each device was subjected to the same tests independently using the exact same steps with the same industry standard benchmarks. Each test was run for three iterations in order to improve the accuracy of performance analysis.

SPEC CPU2000

The SPEC benchmarks are published by the Systems Performance Evaluation Cooperative and consist of a group of codes that are run on various computers by the hardware vendors to compare the speed of different computers. SPEC CPU2000 focuses on compute-intensive performance, which means these benchmarks emphasize the performance of the computer's processor (CPU), the memory architecture, and compilers. SPEC CPU2000 provides a comparative measure of integer and/or floating point compute-intensive performance. The benchmark codes were selected so that they represented different types of calculations and they were an excellent indication of the cumulative performance of a computer. The source codes were written in FORTRAN, C, C++ and hence the necessary compilers were installed in the devices under test for compiling the codes. The ratio for each of the benchmarks was calculated using a SPEC-determined reference time and the run time of the benchmark. For SPEC CPU2000, the reference machine was a Sun Ultra5 10 workstation with a 300-MHz SPARC processor and 256MB of memory, and the machine was given a SPECint2000 and SPECfp2000 score of 100. More information on this test tool is available at http://www.spec.org/cpu2000

Tests were performed to obtain benchmark scores for the three processors under consideration with identical test conditions. Tolly Group engineers obtained the SPEC CPU2000 configuration files from the SPEC.org Web site where the files are publicly available for download.

Engineers generated measurement scores by executing all the benchmarks provided by the tool on all the devices under consideration. The scores of SPECint_base2000 and SPECfp_base2000 were used for performance comparison of the devices. The larger the SPECFP or SPECINT number the faster the computer.

Tests were conducted as per the instructions provided by the test tool. The desired benchmarks were selected and executed.

Test results were recorded as the aggregate and individual scores generated by the test tool. Three test runs were executed and the average of the results was used for the analysis and comparison of different processors under consideration.

PCMark05

PCMark05 basically is a component-level benchmark developed and distributed by Futuremark. It is designed to be a unified benchmark to test PCs on any platform, specifically geared towards home and office users (laptops, desktops and workstations). More information on PCMark05 is available at http://www.futuremark.com.

In the System Test Suite, 11 tests were conducted to measure different components of the device and the results of these tests, as well as the total score (PCMark score), depend on all components. The System Test Suite stresses the processor, system bus, memory (cache and RAM) and graphics performance.

In the CPU Test Suite, engineers conducted eight CPU-specific tests to measure and stress both the integer and the floating-point unit, including some Intel® Streaming SIMD Extensions (SSE), SSE2 and SS3 optimizations. They are designed to test processor performance, where frequency and cache size are the major parameters influencing performance.

In the 16 memory tests found in Memory Test Suite, different operations were performed using several block sizes in order to determine the speed of Level 1 and Level 2 cache, as well as system memory. These operations were read, write, read-modify-write and random access.

The overall system, CPU and memory scores were calculated based on the performance of the processor and its components with these individual benchmarks.

The tests were conducted as per the instructions provided by the test tool vendor. The desired benchmarks were selected and executed.

Test results were recorded as the aggregate and individual scores generated by the test tool. Three test runs were executed and the average of the results was used for the analysis and comparison of different processors under consideration.

SANDRA 2007

SiSoftware SANDRA 2007 (the System Analyzer, Diagnostic and Reporting Assistant) is an information and diagnostic utility that benchmarks device performance in CPU Arithmetic, CPU Multi-Media, File System, Removable Storage, CD-ROM/DVD drives, Memory Bandwidth, Cache and Memory Bandwidth, Network/LAN Bandwidth, Internet/ISP Connection and Internet/ISP Peerage.

The SANDRA suite used for this testing basically consisted of two benchmark sets: memory bandwidth and cache and memory access benchmark. This tool measures the memory bandwidth performance based on both integer and floating point SSE instructions set.

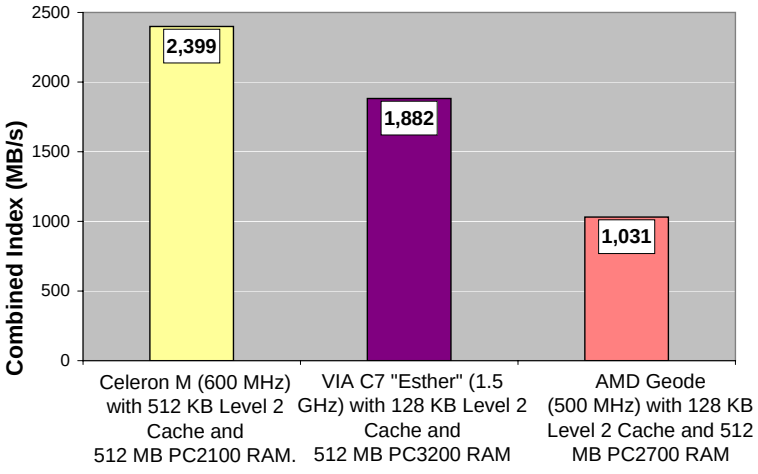
For the cache and memory access benchmark, the tool takes measurements based upon processor effectiveness to access blocks of data either from the cache memory and RAM. More information on the SANDRA 2007 benchmark is available at http://www.sisoftware.co.uk

For the SANDRA 2007 benchmark, engineers employed the following tests: Memory Bandwidth benchmark which measured the RAM Bandwidth Integer Buffered iSSE (MB/s), RAM Bandwidth Integer Buffered iSSE2 (MB/s), RAM Bandwidth Floating Buffered iSSE (MB/s) and RAM Bandwidth Floating Buffered iSSE2 (MB/s).

Lastly, for the Cache and Memory Access benchmark, engineers measured the Combined Index (MB/s) on all three devices.

Tests were conducted as per the instructions provided by the test tool. The desired benchmarks were selected and executed.

Test results were recorded as the aggregate and individual scores generated by the test tool. Three test runs were executed and the average of the results was used for the analysis and comparison of different processors under consideration.



Source: The Tolly Group, September 2006

Figure 4

Fair Testing Charter ™ and Interaction with Competitors

In accordance with The Tolly Group's process, AMD and VIA Technologies representatives were contacted via E-mail on 28 April 2006 and invited to collaborate on the test — to review the test plans, the product levels and configurations of their products and to review and comment on their results. Neither company responded to the E-mail invitations.

For more information on this process, please see: http://www.Tolly.com/FTC.aspx.

All of the competitive products were acquired through normal distribution channels since they represent off-the-shelf components.

The Tolly Group is a leading global provider of third-party validation services for vendors of IT products, components and services.

The company is based in Boca Raton, FL and can be reached by phone at (561) 391-5610, or via the Internet at http://www.tolly.com, sales@tolly.com

Test Equipment Summary

The Tolly Group gratefully acknowledges the providers of test equipment used in this project.

Vendor	Product	Web
Standard Performance Evaluation Corporation	SPEC CPU2000 v.1.3	http://www.spec.org
Futuremark Corporation	PCMark05 Pro v.1.1.0	http://www.futuremark.com
SiSoftware Ltd.	SANDRA 2007 Pro Business v.2007.5.10.98	http://www.sisoftware.net
ATEN International Co. Ltd.	ALTUSEN KVM Switch Model KH88	http://www.aten.com

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