Power Mac G5

Technology and Performance Overview
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The Power Mac G5 opens up a wealth of computing opportunities:

- Graphic designers can manipulate Adobe Photoshop images for print, web, and animation almost two times faster than on the fastest PC.¹
- Video producers can edit, add effects, and composite multiple streams of DV, SD, and HD content in real time.
- Musicians and audio producers can process an unprecedented number of audio tracks, all with complex filters and digital effects.
- Scientists can execute high-precision math on extremely large 64-bit numbers and return results faster than ever.
- Artists, game developers, architects, and researchers can model and render complex 3D visualizations at remarkable speeds.

“The more power you have, the faster you can work. That’s why Apple’s G5 represents an important step forward for anyone with compute-intensive work. It’s one intensely fast machine.”

—Bob Freeman
Computerworld

In June 2003, Apple introduced the Power Mac G5 to rave reviews. Exceeding the high-performance, no-compromise requirements of demanding professionals, the Power Mac G5 made great strides in processing power, broke the 4GB memory barrier, introduced the industry's fastest frontside bus, and came loaded with groundbreaking features. In the past year, the Power Mac G5 has established itself as the premier choice across multiple industries—from design and print, to film and video, to music and audio, to science and technology—and has proved to be the ideal system for designing stunning ad campaigns, mapping the human genome, and everything in between.

With the latest release of the Power Mac G5, Apple introduces an all–dual processor lineup, a liquid-cooled dual 2.5GHz model, an 8x-speed SuperDrive across the line, and new, more powerful graphics options. With the most popular professional applications—Adobe Photoshop, Logic, Final Cut Pro, HMMER, and others—optimized to take advantage of all that power, it’s no wonder the Power Mac G5 remains one of the most coveted personal computers ever introduced.

At the center of this revolutionary system is the PowerPC G5, the ultrafast 64-bit processor developed in collaboration with IBM and produced using state-of-the-art IBM process technology. Combine this advanced processor with the industry’s fastest frontside bus, a high-bandwidth system architecture, and plenty of high-speed memory, and the Power Mac G5 outperforms even the fastest Pentium 4–based desktop computers.¹ And since the G5 processor runs 32-bit code natively, your favorite Mac OS X applications will run faster on the new Power Mac, with no optimization or upgrades required.

The Power Mac G5 also features a host of leading-edge, industry-standard technologies, dramatically accelerating digital production, scientific solutions, and everyday work. High-speed PCI-X slots allow you to connect to external devices using industry-leading expansion technology.² Serial ATA enables fast access to up to 500GB of internal storage³ for huge databases and media assets, and an AGP 8X Pro graphics controller supports the next generation of graphics cards for eye-popping 2D and 3D visuals. What’s more, the Power Mac features an efficient cooling system based on superquiet, low-speed fans, and a revolutionary liquid cooling system, all packed into an anodized aluminum chassis with easy access to internal components.

Whether you’re a video editor, a musician, a graphic artist, or a scientist, the Power Mac G5 is your path to enhanced creativity and unparalleled productivity. Discover how you can accomplish things you never dreamed possible.
Key Features

The Power Mac G5 set a new standard for desktop computing at its introduction, and it just keeps getting better. Powerful 64-bit processing, the industry’s fastest frontside bus, up to 8GB of fast memory, and the latest I/O technologies are all packed into an amazingly quiet enclosure.

Inside the Power Mac G5

1. **Dual 64-bit PowerPC G5 processors.** The ultrafast 64-bit processor—with clock speeds up to 2.5GHz, an optimized Velocity Engine, and two double-precision floating-point units—accelerates all types of applications.

2. **Frontside bus up to 1.25GHz.** The industry’s fastest frontside bus maximizes processor performance by rapidly transferring instructions and data to and from the processor.

3. **Dual independent frontside buses.** An industry first, dual PowerPC G5 systems have two dedicated frontside buses for an extraordinary combined throughput of up to 20 GBps.

4. **400MHz DDR SDRAM.** A superefficient 128-bit memory bus speeds data in and out of main memory at up to 6.4 GBps.

5. **Up to 8GB of addressable memory.** Today’s Power Mac G5 supports system memory up to 8GB,2 ideal for manipulating high-resolution multimedia files and enormous data sets.

6. **AGP 8X Pro.** The latest 533MHz, 32-bit graphics interface supports high-performance graphics cards for stunning 2D and 3D images and animations.

7. **133MHz PCI-X.** The industry’s fastest PCI-X slots allow you to connect to high-performance devices using advanced expansion technology.2

8. **Serial ATA.** Serial ATA is the latest ATA mass storage technology. The Power Mac G5 has two independent channels of 150-MBps Serial ATA for fast access to high-capacity hard drives, providing up to 500GB of internal storage.3

9. **8x SuperDrive.** A versatile DVD-R/CD-RW optical drive supports data archiving and media authoring at double the previous DVD-burning speeds.

10. **Wireless connections.** Add an AirPort Extreme Card to network wirelessly—or the Bluetooth module to connect to cell phones, PDAs, or Apple’s wireless keyboard and mouse.

11. **High-performance I/O.** Fast ports make it easy to connect to the latest industry-standard solutions: Gigabit Ethernet networks, FireWire 800 and USB 2.0 peripherals, and optical digital audio equipment.

12. **Quiet enclosure.** The Power Mac G5 sports an innovative chassis designed to cool system components efficiently for the quietest possible operation.
Ultrafast 64-Bit PowerPC G5 Processor

The Power Mac G5 marked the arrival of a 64-bit architecture to the personal computer market. An all-new implementation of the PowerPC architecture, the G5 processor is based on the execution core of IBM’s POWER Architecture. Apple has teamed with IBM to leverage this industry-leading design for the next generation of personal computing.

The result? The revolutionary PowerPC G5, with clock speeds of up to 2.5GHz, puts enormous, seemingly infeasible tasks within easy reach. In addition to a highly parallel execution core, it uses 64-bit data paths and registers to perform huge integer calculations and highly precise floating-point math in a single clock cycle—dramatically accelerating audio, video, graphics, and scientific workflows. In addition, 64-bit processing delivers a similarly dramatic leap in the amount of memory supported, enabling the Power Mac G5 to be configured with up to 8GB of memory.

An Exponential Leap in Computing Power

The labels “32-bit” and “64-bit” characterize the width of a microprocessor’s data stream, which is a function of the sizes of its registers and the internal data paths that feed the registers. A 64-bit processor moves data and instructions along 64-bit-wide data paths—compared with the 32-bit-wide paths on 32-bit processors, such as Intel’s Pentium 4 and Xeon. In addition, 64-bit processors have wide registers that can store extremely large or extremely precise 64-bit numbers.

The leap from 32-bit to 64-bit processing represents an exponential advance in computing power. With 32-bit registers, a processor has a dynamic range of $2^{32}$, or 4.3 billion—which means it can express integers from 0 to 4.3 billion. With 64-bit registers, the dynamic range catapults to $2^{64}$, or 18 billion billion—4.3 billion times larger than the range of a 32-bit processor. This means that computations involving very large integers or very precise numbers with extended decimals can be completed in one pass through the functional units, rather than several passes.
Vast Amounts of Addressable Memory

The move to 64-bit processing results in a similarly dramatic leap in the amount of memory supported. Computers keep track of data stored in memory using memory addresses. A memory address is a special kind of integer, which points to one byte in memory. Since memory addresses are computed in 64-bit registers capable of expressing 18 billion billion integers, the PowerPC G5 can theoretically address 18 exabytes (18 billion billion bytes) of virtual memory.

In practice, memory addressing is defined by the physical address space of the processor. The PowerPC G5, with 42 bits of physical address space, supports a colossal $2^{42}$ bytes, or 4 terabytes, of system memory. Although it’s not currently feasible to purchase 4 terabytes of RAM, the advanced architecture of this processor allows for plenty of growth in the future.

More practical and still unprecedented for a personal computer, the Power Mac G5 can be configured with 8GB of addressable memory—the same amount as is supported by a typical PC. Such large quantities of memory enable the system to contain a complex 3D model, massive digital images, a scientific simulation, or a sequence of video entirely in RAM. When data is stored in memory, the processor can access it 40 times faster than from the hard drive, drastically reducing the time to access, modify, and render the data and making it feasible to tackle gigantic projects on a desktop system.

Next-Generation PowerPC Architecture

The PowerPC G5 is a highly parallel implementation of the PowerPC architecture, capable of handling large numbers of tasks at the same time. It’s based on the execution core of the IBM POWER Architecture that drives IBM’s top-of-the-line enterprise servers.

Apple and IBM leveraged this industry-leading design to introduce the 64-bit PowerPC G5 processor into the next generation of personal computers. The development of the PowerPC G5 builds on previous PowerPC designs, combining an optimized Velocity Engine and two double-precision floating-point units with a superscalar, superpipelined execution core that supports up to 215 simultaneous instructions. This high-bandwidth core has over 12 discrete functional units that can process instructions in parallel.

For more information about the PowerPC G5 architecture, see www.apple.com/g5processor.
The execution core contains 12 discrete functional units:

- A dual-pipelined Velocity Engine uses two very large queues and dedicated 128-bit registers to perform single-instruction, multiple-data (SIMD) processing.
- Two 64-bit double-precision floating-point units provide the speed and accuracy required for highly complex mathematical computations.
- Two 64-bit integer units perform calculations for a broad range of simple and complex computing tasks.
- Two load/store units manage data as it is processed, keeping the processor’s registers filled for faster operations.
- The condition register stores the results of branch predictions to improve the accuracy of future predictions.
- The branch prediction unit uses innovative three-component logic that increases the accuracy of speculative operation and maximizes processor efficiency.
Native Compatibility with 32-Bit Application Code

On other platforms, switching to a 64-bit computer requires migrating to a 64-bit operating system (and purchasing 64-bit applications) or running a 32-bit operating system in a slow emulation mode. With the PowerPC G5, the transition to 64-bit performance is seamless: Current 32-bit code—such as existing Mac OS X and Classic applications—runs natively at processor speed, with no interruptions to your workflow and no required additional investments in software.

Unlike competing technologies, the PowerPC architecture was designed from the beginning to run both 32-bit and 64-bit application code. This enables the G5 processor to run Mac OS X natively for an immediate performance boost. In addition, more and more of the most popular applications, including Mac OS X itself, have been optimized for the PowerPC G5, so performance gains are even greater.

State-of-the-Art Process Technology from IBM

The PowerPC G5 is fabricated in one of IBM's world-class semiconductor manufacturing facilities. It uses 90-nanometer circuitry with more than 400 meters (1300 feet) of ultrathin copper wiring—less than 1/1000 the width of a human hair. With more than 58 million transistors, a high-performance silicon-on-insulator (SOI) process for faster operation, and copper interconnects for improved conductivity, this scalable design contributes to clock speeds of up to 2.5GHz.

IBM is a worldwide leader in semiconductor processor technologies, with a $3 billion, state-of-the-art facility in East Fishkill, New York.
High-Bandwidth System Architecture

The Power Mac G5 matches the advanced technology of the PowerPC G5 with a high-bandwidth system architecture. It begins with a frontside bus running at up to 1.25GHz—one on each processor in dual processor systems—for maximum throughput to and from the PowerPC G5. A point-to-point system controller allows data to move directly between all subsystems, without impacting the processor. Bandwidth is further optimized by a 400MHz, 128-bit memory bus; an AGP 8X Pro graphics bus; and a HyperTransport interface that connects the PCI-X controller and the I/O subsystems to the system controller. The result is phenomenal throughput for tackling the most intensive image editing, media production, and scientific computing tasks—all alleviating the limitations and bottlenecks of the traditional PC.

**System Architecture**

1. **Frontside bus up to 1.25GHz.** Provides up to 10-GBps bandwidth per processor.
2. **Dual independent frontside buses.** Provides up to 20-GBps aggregate bandwidth.
3. **Advanced system controller.** Uses a point-to-point architecture to enable data to pass directly between subsystems.
4. **400MHz memory.** A 128-bit memory architecture supports high-speed PC3200 DDR SDRAM.
5. **AGP 8X Pro graphics bus.** At 533MHz, doubles the throughput of AGP 4X and provides added power for high-performance graphics cards.
6. **133MHz PCI-X expansion.** Supports advanced high-performance PCI devices, providing total throughput of up to 2 GBps.
7. **High-performance I/O.** Integrates hard disk drives; SuperDrive; and FireWire 800, USB 2.0, networking, and optical digital audio ports.
8. **Serial ATA storage.** Supports 150-MBps Serial ATA drives for up to 500GB of fast internal storage.
The dual-channel frontside bus allows data to travel to and from the PowerPC G5 processor at the same time. Each PowerPC G5 has its own dedicated interface to maximize throughput—compared with dual Xeon-based systems, in which the processors must share a single bus.

**Up to 1.25GHz Frontside Bus**

The performance advantages of the PowerPC G5 begin with an innovative Double Data Rate (DDR) frontside bus that speeds up communication between the processor and the memory controller. Unlike conventional processor interfaces, which carry data in only one direction at a time, this dual-channel frontside bus has two 32-bit point-to-point links (64 bits total): One link travels into the processor and another travels from the processor, which means no wait time while the processor and the system controller negotiate which will use the bus or while the bus switches direction. This enables data to move in opposite directions simultaneously and is a dramatic improvement over previous processor interfaces. The elastic interface self-tunes during startup for optimal signal quality.

In dual processor systems, each G5 processor has its own bidirectional interface to the system controller, for total bandwidth of up to 20 GBps, over three times the 6.4-GBps maximum bandwidth of Pentium 4–based systems. In addition to providing fast throughput to main memory, this high-performance frontside bus architecture enables each PowerPC G5 to discover and access data in the other processor’s caches—further increasing performance on dual processor systems.

**Advanced System Controller**

An advanced system controller is central to the overall performance of the Power Mac G5. This revolutionary application-specific integrated circuit (ASIC)—among the industry’s fastest—is built using the same state-of-the-art IBM process technology as the PowerPC G5 processor. A superefficient point-to-point architecture provides each primary subsystem with dedicated throughput to main memory, so massive amounts of data can traverse the system without contention for bandwidth. In contrast, subsystems that share a bus, as on other personal computers, must deal with time-consuming arbitration while they negotiate for access and bandwidth across a common data path.

**400MHz Memory**

The Power Mac G5 features a 128-bit memory controller supporting 400MHz DDR SDRAM. DDR memory allows the system to read and write data on both the rising and falling edge of each clock cycle. By combining fast DDR memory with a wider 128-bit interface that can address two banks of SDRAM at a time, the Power Mac G5 can reach a memory throughput of up to 6.4 GBps—more than double the throughput of the Power Mac G4. For even greater performance, direct memory access (DMA) works with the point-to-point system controller to give each subsystem—such as PCI and graphics slots—its own 6.4-GBps interface to main memory, without needing to interact with the processor.

With the 64-bit G5 processor, the Power Mac G5 can address more memory than any previous Macintosh and many desktop PCs. Power Mac G5 systems can hold up to eight DIMMs for up to 8GB of memory. This high-speed, high-capacity memory architecture enables graphics, video, audio, and scientific applications to run radically faster. Enormous files and data sets can be loaded into RAM for rapid access by the PowerPC G5—without having to access system storage. Data can be retrieved from memory 40 times faster than from the hard drive. In fact, accessing the first critical word of data from memory is 60,000 times faster than from a hard drive, so manipulation and analysis of data can be performed at remarkable speeds.
AGP 8X Pro Graphics Bus

The Power Mac G5 integrates the latest graphics interface, AGP 8X Pro, for high-performance gaming and advanced graphics production. Compared with the AGP 4X interface in previous Power Mac systems, this specification doubles the maximum transfer rate and doubles the amount of data transferred in a single AGP bus cycle. The 32-bit, 66MHz AGP 8X Pro bus strobes eight times per clock cycle, resulting in a 533MHz data rate and a maximum bandwidth of 2.1 GBps. This increased performance enables graphics-intensive applications to achieve higher resolutions with improved complexity and texturing, for a more immersive visual experience.

The “Pro” component of the AGP 8X Pro specification is designed to provide additional electrical power to the graphics card. The Power Mac G5 uses High Power AGP, delivering 75 watts to support advanced, higher-powered graphics cards, such as the optional ATI Radeon 9800 XT.

133MHz PCI-X Expansion

The Power Mac G5 introduces Macintosh users to PCI-X. This advanced expansion protocol addresses the need for higher-performance PCI devices, increasing the speed from 33MHz to 133MHz and throughput from 266 MBps to 2 GBps. PCI-X also operates more efficiently than PCI, resulting in more usable bandwidth at any clock frequency—ideal for high-bandwidth applications. The PCI-X specification uses 3.3V signaling and is designed for compatibility with legacy 3.3V and Universal cards.

High-Performance I/O

The Power Mac G5 architecture uses the HyperTransport protocol to integrate the I/O subsystems and connect them to the system controller. Serial ATA, Gigabit Ethernet, FireWire, USB 2.0, optical digital audio, and analog audio are all integrated through two bidirectional 800MHz HyperTransport interconnects for a maximum throughput of 1.6 GBps.

For more information about the many expansion and I/O options available on the Power Mac G5, see the section “State-of-the-Art Expansion.”

Serial ATA Storage

Serial ATA is the next-generation industry-standard storage interface, replacing the Parallel ATA interface. Designed to keep pace with the demands of digital video creation and editing, audio storage and playback, and other data-intensive applications, Serial ATA supports 1.5-Gbps throughput per channel (equivalent to a data rate of 150 MBps).

The Power Mac G5 can hold two internal Serial ATA drives for a total capacity of up to 500GB of storage. Each drive is on an independent bus, so there’s no competition for drive performance, as with Parallel ATA. Performance is improved even further when drives are striped using software RAID in Mac OS X.
A Giant Leap over the Power Mac G4

The Power Mac G5 represents a huge leap over its predecessor. With the 64-bit G5 processor, high-bandwidth architecture, and state-of-the-art expansion options, Power Mac G5 users will realize performance gains in media authoring, video editing, real-time effects, audio synthesis, image processing, 3D rendering, numerical analysis, and physical modeling.

Compare the top-of-the-line dual 1.42GHz Power Mac G4 with the dual 2.5GHz Power Mac G5:

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<th>Power Mac G4</th>
<th>Power Mac G5</th>
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<td>Processor</td>
<td>32-bit PowerPC G4</td>
<td>64-bit PowerPC G5</td>
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<tr>
<td>Clock speed</td>
<td>1.42GHz</td>
<td>2.5GHz</td>
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<td>Frontside bus</td>
<td>167MHz</td>
<td>1.25GHz per processor</td>
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<td>Frontside bus bandwidth</td>
<td>1.3 Gbps</td>
<td>10 Gbps</td>
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<td>Dual processor interface</td>
<td>One shared bus</td>
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<td>Dual processor bandwidth</td>
<td>1.3 Gbps</td>
<td>20 Gbps</td>
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<tr>
<td>Maximum memory</td>
<td>2GB</td>
<td>8GB</td>
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<td>Memory</td>
<td>333MHz, 64-bit DDR SDRAM</td>
<td>400MHz, 128-bit DDR SDRAM</td>
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<td>Memory bandwidth</td>
<td>2.7 Gbps</td>
<td>6.4 Gbps</td>
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<td>Graphics</td>
<td>AGP 4X</td>
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<tr>
<td>PCI expansion</td>
<td>33MHz, 64-bit PCI</td>
<td>133MHz, 64-bit PCI-X</td>
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<tr>
<td>PCI throughput</td>
<td>266 MBps</td>
<td>2 Gbps</td>
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<tr>
<td>ATA storage</td>
<td>100 MBps shared</td>
<td>150 MBps per channel</td>
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</table>
High-Performance Graphics and All-Digital Displays

The Macintosh is the premier platform for processing digital media of all types. The Power Mac G5 features a powerful AGP 8X Pro graphics interface and the latest in high-performance graphics cards from NVIDIA and ATI. For crystal-clear viewing, Apple’s gorgeous all-digital displays are the perfect complement to the G5. And support for dual displays—including two Apple LCD displays—is built into every system.6

AGP 8X Pro Graphics Options

3D graphics, modeling, animation, visualization, and the latest generation of games require the fastest graphics cards available. That’s why the Power Mac G5 includes AGP 8X Pro, the industry-leading specification for high-bandwidth graphics and high-powered graphics cards.

Every Power Mac G5 system is built with a graphics card installed in the 533MHz AGP 8X Pro slot. Standard configurations feature the NVIDIA GeForce FX 5200 Ultra with 64MB of video SDRAM or the ATI Radeon 9600 XT with 128MB of video SDRAM. The GeForce FX 5200 Ultra uses the CineFX engine and NVIDIA’s advanced Lightspeed Memory Architecture II for photorealistic 3D graphics in today’s games and design applications. The Radeon 9600 XT kicks performance up a notch with a quad-pipe architecture, SmartShader 2.0 technology, and the HyperZ III+ memory architecture—for ultrarealism in gaming and visualization applications.

For the ultimate graphics experience, you can order a system with the ATI Radeon 9800 XT with 256MB of SDRAM.7 This advanced card has eight parallel pixel pipelines and a superfast 256-bit memory interface—enabling incredible 3D rendering, sophisticated real-time effects, and unsurpassed image quality. A generous 256MB frame buffer supports large textures in the latest games and design applications, delivering a truly cinematic visual experience.

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<tr>
<th>Graphics card options</th>
<th>NVIDIA GeForce FX 5200 Ultra</th>
<th>ATI Radeon 9600 XT</th>
<th>ATI Radeon 9800 XT</th>
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<tr>
<td>Memory architecture</td>
<td>Lightspeed II</td>
<td>HyperZ III+</td>
<td>HyperZ III+</td>
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<td>Memory interface</td>
<td>128-bit</td>
<td>128-bit</td>
<td>256-bit</td>
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<td>Effects engine</td>
<td>CineFX 2.0</td>
<td>SmartShader 2.0</td>
<td>SmartShader 2.1</td>
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<tr>
<td>Frame buffer memory</td>
<td>64MB</td>
<td>128MB</td>
<td>256MB</td>
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<tr>
<td>Triangles per second</td>
<td>75 million</td>
<td>200 million</td>
<td>400 million</td>
</tr>
<tr>
<td>Fill rate (texels per second)</td>
<td>1.2 billion</td>
<td>1.6 billion</td>
<td>3.2 billion</td>
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<tr>
<td>Memory bandwidth</td>
<td>8.8 GBps</td>
<td>9.9 GBps</td>
<td>23 GBps</td>
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</table>
Apple Flat-Panel LCD Displays

Apple offers a lineup of pure-digital flat-panel displays that provide superior image quality, vivid color, and the industry's best wide-viewing technology. With a compact footprint to fit neatly in your work environment, Apple displays deliver the benefits of thin and light LCD technology, with twice the brightness, twice the sharpness, and twice the contrast of a standard CRT display. And they can be calibrated for color-managed workflows and will maintain consistent color and quality without frequent recalibration.

For more information about Apple displays, visit www.apple.com/displays.

Support for Dual Displays

All Power Mac G5 systems are equipped with an Apple Display Connector (ADC) for connecting an Apple display and a DVI connector for a second digital display—with support for both extended desktop and video mirroring modes. Extended desktop mode lets you distribute work across two displays, allowing more room for viewing rich content and complex applications that use floating palettes and long timelines. For example, Final Cut Pro users can view the application interface on the primary display while watching the final video output on the other. In contrast, video mirroring outputs identical information on both displays, enabling you to control a presentation on one display while the audience watches it on a second display or projected image.

A DVI to VGA adapter is included for connecting to VGA displays, such as CRTs or projectors. The optional Apple DVI to ADC Adapter enables you to connect your Power Mac to two Apple displays, including two Apple Cinema HD Displays for an amazing 3840-by-1200-pixel resolution, or more than 4.5 million pixels. For even more flexibility, you can order the Apple DVI to Video Adapter to connect to S-video and composite devices, such as TVs, VCRs, or overhead projectors with S-video or RCA (composite) connectors.
State-of-the-Art Expansion

The Power Mac G5 is packed with state-of-the-art technologies, making it easy to expand the capabilities of your system as your projects grow and your workflow evolves. A removable side panel provides quick access to slots and bays, so you can add memory, a second hard drive, or an AirPort Extreme Card—all without tools. Ports on the front and back panels allow you to plug in a variety of industry-standard input and output devices, including optical digital audio components, high-bandwidth FireWire devices, and USB 2.0 peripherals.

Up to 8GB of Main Memory

The Power Mac G5 has four or eight DIMM slots that use fast PC3200 DDR SDRAM. This high-performance memory operates at 400MHz for a throughput of up to 6.4 GBps. Standard configurations come with 256MB or 512MB of RAM; memory is scalable up to 8GB, so you can add RAM as your application and workflow requirements increase.

PCI-X Expansion Slots

The use of PCI cards or higher-performance PCI-X cards enables the Power Mac G5 to perform specialized tasks, such as video acceleration or audio digital signal processing (DSP). For massive system storage, you can add a Fibre Channel PCI Card to connect to Xserve RAID, Apple’s high-performance storage system.

Systems can be configured with PCI or PCI-X expansion technology: Three 64-bit PCI-X slots allow you to add one card running at 133MHz and two cards running at 100MHz; or three 64-bit PCI slots allow you to add three 33MHz cards. PCI-X is designed to support 3.3V signaling and Universal 33MHz and 66MHz PCI cards.

Up to 500GB of Internal Storage

The Power Mac G5 has two Serial ATA hard drive bays for up to 500GB, or half a terabyte, of fast internal mass storage—ideal for video, audio, and high-resolution graphics. Built-in software RAID allows you to stripe the two drives for increased performance or mirror them for high reliability.

What’s more, it’s easy to add storage as your needs grow. Single-drive systems come with the cabling to connect a second hard drive, and the easy-to-remove side panel allows you to insert a new drive yourself, without tools.
Versatile SuperDrive

Every Power Mac G5 ships with an internal SuperDrive, a combination DVD-R and CD-RW optical drive, for reading and writing to DVDs and CDs. Disc burning is integrated into Apple applications such as DVD Studio Pro, iDVD, and iTunes—making it easy to author CDs and DVDs for use in most professional and consumer players. The SuperDrive is also ideal for backup. CDs can hold up to 700MB of data; DVDs can store 4.7GB of data, the equivalent of about seven CDs, 18 Zip 250 disks, or 3200 floppy disks. With Mac OS X, you can archive data to CD and DVD directly from the Finder.

The industry-standard SuperDrive reads dozens of standard CD and DVD formats, and the latest model burns DVDs twice as fast as before. It writes DVD-R discs at up to 8x speed, reads DVDs at up to 10x speed, writes CD-R discs at up to 24x speed, writes CD-RW discs at up to 10x speed, and reads CDs at up to 32x speed.
FireWire and USB 2.0

FireWire is one of the fastest peripheral standards ever developed, making it easy to connect high-bandwidth devices such as DV cameras, hard drives, and digital music players. And since FireWire cables carry power, the Power Mac G5 can recharge your portable device's batteries, even while you're using the device.

All Power Mac G5 systems have one FireWire 400 port on the front and one on the back of the enclosure, as well as a next-generation FireWire 800 port on the back. FireWire 800 doubles the throughput of the original FireWire 400, from 400 to 800 Mbps. In addition, FireWire 800 works over distances of up to 100 meters, making it ideal for operation in larger facilities.

Three USB 2.0 ports, one on the front and two on the back—plus two USB 1.1 ports on the keyboard—connect to printers, scanners, graphics tablets, keyboards, microphones, speakers, joysticks, and other industry-standard input and output devices.


Wired and Wireless Networking

Gigabit (10/100/1000BASE-T) Ethernet is built into every Power Mac G5, and the autosensing port makes it easy to connect to the network. Wireless networking is just as simple using the optional 54-Mbps AirPort Extreme Card and AirPort Extreme Base Station. The optional Bluetooth module and antenna allow you to connect wirelessly to a range of digital devices, such as cell phones, personal digital assistants, printers, and Apple's wireless keyboard and mouse.

For more information on AirPort Extreme, see www.apple.com/airport. For more information on Bluetooth, see www.apple.com/bluetooth.

Optical Digital Audio

The Power Mac G5 features a comprehensive set of audio capabilities not commonly found in personal computers. State-of-the-art optical digital audio input and output ports use the S/PDIF (Sony/Philips Digital Interface) protocol over Toslink cables for connecting to devices such as decks, receivers, digital instruments, and even home theater systems. The optical digital audio ports on the Power Mac G5 support stereo optical digital audio and 5.1 surround sound speaker systems. Because optical digital audio transmits data as impulses of light rather than electrical signals, it enables true noise-free, pristine sound, eliminating troublesome ground loops.

Optical digital audio specifications

<table>
<thead>
<tr>
<th></th>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data format</td>
<td>S/PDIF (IEC60958-3)</td>
<td>S/PDIF (IEC60958-3)</td>
</tr>
<tr>
<td>Connector type</td>
<td>Toslink optical (IEC60874-17)</td>
<td>Toslink optical (IEC60874-17)</td>
</tr>
<tr>
<td>Sample rates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– External clock mode</td>
<td>32kHz, 44.1kHz, or 48kHz</td>
<td>32kHz, 44.1kHz, or 48kHz</td>
</tr>
<tr>
<td>– Internal clock mode</td>
<td>16kHz to 96kHz</td>
<td>32kHz, 44.1kHz, or 48kHz</td>
</tr>
<tr>
<td>Bits per sample</td>
<td>16 or 24</td>
<td>16 or 24</td>
</tr>
<tr>
<td>Signal-to-noise ratio</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– External clock mode</td>
<td>Greater than 130 dB</td>
<td>Greater than 130 dB</td>
</tr>
<tr>
<td>– Internal clock mode</td>
<td>Greater than 110 dB</td>
<td>Greater than 130 dB</td>
</tr>
<tr>
<td>Total harmonic distortion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>– External clock mode</td>
<td>Less than 0.00003 percent</td>
<td>Less than 0.00003 percent</td>
</tr>
<tr>
<td>– Internal clock mode</td>
<td>Less than 0.00003 percent</td>
<td>Less than 0.00003 percent</td>
</tr>
</tbody>
</table>

Based on typical performance specifications.
Analog Audio

Completing the audio features of the Power Mac G5 are high-quality, analog stereo audio line in and line out ports; and a convenient minijack on the front panel that makes it easy to plug in headphones.

**Analog input specifications**

<table>
<thead>
<tr>
<th>Line input</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample rates</td>
<td>32kHz, 44.1kHz, or 48kHz</td>
</tr>
<tr>
<td>Bits per sample</td>
<td>16 or 24</td>
</tr>
<tr>
<td>Jack type</td>
<td>3.5-mm stereo</td>
</tr>
<tr>
<td>Input impedance</td>
<td>Greater than 47K ohms</td>
</tr>
<tr>
<td>Maximum input voltage</td>
<td>2V_{rms} (+8.2 dBu)</td>
</tr>
<tr>
<td>Frequency response</td>
<td>20Hz to 20kHz, +0.5 dB/-3 dB</td>
</tr>
<tr>
<td>Signal-to-noise ratio</td>
<td>Greater than 90 dB</td>
</tr>
<tr>
<td>Total harmonic distortion</td>
<td>Less than 0.006 percent</td>
</tr>
</tbody>
</table>

Based on typical performance specifications.

**Analog output specifications**

<table>
<thead>
<tr>
<th>Line output</th>
<th>Headphone jack</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample rates</td>
<td>32kHz, 44.1kHz, or 48kHz</td>
</tr>
<tr>
<td>Bits per sample</td>
<td>16 or 24</td>
</tr>
<tr>
<td>Jack type</td>
<td>3.5-mm stereo</td>
</tr>
<tr>
<td>Output impedance</td>
<td>24 ohms</td>
</tr>
<tr>
<td>Output voltage</td>
<td>1.4V_{rms} (+1 dBu)</td>
</tr>
<tr>
<td>Frequency response</td>
<td>20Hz to 20kHz, +0.5 dB/-3 dB</td>
</tr>
<tr>
<td>Signal-to-noise ratio</td>
<td>Greater than 90 dB</td>
</tr>
<tr>
<td>Total harmonic distortion</td>
<td>Less than 0.01 percent</td>
</tr>
<tr>
<td>Output power (into 32 ohms)</td>
<td>20 mW</td>
</tr>
</tbody>
</table>

Based on typical performance specifications.
Innovative Enclosure Design for Quiet Operation

An industry-leading system demands an exceptional enclosure design. The Power Mac G5 features a modern chassis constructed of anodized aluminum for a sleek, professional exterior. Inside, the efficient cooling system uses low-speed fans and a revolutionary liquid cooling system for superquiet operation—twice as quiet as a Power Mac G4.

Intelligent Cooling System Using Low-Speed Fans

The Power Mac enclosure is divided into four discrete thermal zones that compartmentalize the primary heat-producing components: processor, PCI, storage, and power supply. This allows the system to increase or decrease the temperature of a single zone without affecting the others and without unnecessary cooling. The front panel is 35 percent perforated, so cooler outside air can enter, flow over the heat-producing components, and escape through the perforations in the rear panel. For added cooling efficiency, an internal air deflector channels airflow over the processor heat sinks and the PCI slots.

Each thermal zone is equipped with its own fans. Apple has engineered the nine fans to spin at very low speeds for minimum acoustic output. Using 21 different sensors, Mac OS X constantly monitors component temperatures in each zone and dynamically adjusts individual fan speeds to the appropriate levels, achieving the quietest possible operation.
State-of-the-Art Liquid Cooling System

In addition to the low-speed fans, the dual 2.5GHz Power Mac G5 features a new liquid cooling system—the next generation in cooling technology. This system provides a continuous flow of thermally conductive fluid that transfers heat from the processors as they work harder. The heated fluid then flows through a radiant grille, where air passing over cooling fins returns the fluid to its original temperature. The liquid cooling system is also controlled by Mac OS X, which dynamically adjusts the flow of the fluid and the speed of the fans based on the amount of heat being generated. The closed-loop liquid cooling system is completely maintenance free. In addition, because the liquid cooling system is more efficient than a standard heat sink, the Power Mac G5 continues to run quietly, even as system performance reaches new heights.

Easy Access and Usability

The Power Mac G5 has an easy-to-use removable side panel for fast access to expansion slots and bays. Designed for simple operation, the system allows you to add or remove the optical drive or an AirPort Extreme Card without tools. Intuitive drive guides let you add high-capacity hard drives in minutes when your storage needs increase. For peace of mind, an ingenious locking mechanism is integrated into the panel latch, giving you a convenient and elegant way to keep the components inside your computer safe from tampering.

The Power Mac G5 also comes equipped with a complete set of ports on the back panel, in addition to FireWire 400 and USB 2.0 ports and a headphone jack on the front panel. For added convenience, the integrated handles allow you to lift and move your Power Mac safely and easily.
Mac OS X: System Software for the Power Mac G5

Mac OS X combines the power and stability of UNIX with Apple's legendary ease of use. The Power Mac G5 ships with Mac OS X version 10.3 “Panther,” the fourth major release of the Mac OS X operating system. Unlike other 64-bit platforms, no special 64-bit version of the operating system is required; the same operating system runs on all your Mac computers. And because Mac OS X is fully compatible with 32-bit PowerPC application code, the Power Mac G5 eases the migration to 64-bit computing and protects your software investment.

Optimized for G5

Mac OS X Panther features a redesigned 64-bit kernel and updated libraries specifically for the 64-bit PowerPC G5 processor. The updated kernel delivers the most substantial benefits of 64-bit computing by breaking through the 4GB physical memory barrier, allowing the Power Mac G5 to use up to 8GB of physical memory today, and even more in the future.

Runs Both 32-Bit and 64-Bit Macintosh Applications

The PowerPC processor was architected from the ground up with 64-bit instructions in mind, so it can run both 32-bit and 64-bit applications—without emulation or translation software. This means that the 32-bit applications that run on Mac OS X today will run not only natively but also with greater speed on the 64-bit PowerPC G5 processor. This approach allows a smooth transition for both developers and users—and enables users to experience the benefits of 64-bit processing.

Optimized Instructions

Mac OS X includes hand-tuned system math, vector, and image libraries that take maximum advantage of the new faster math functions in the 64-bit PowerPC G5 instruction set. That means unmodified applications that use the system math functions will get an automatic speed improvement on the G5. For example, the square-root function is implemented as a software algorithm on a PowerPC G3 or G4. In contrast, when a square-root calculation is requested on a G5, the math library uses the G5 processor's superfast hardware instruction. This reduces the number of processor cycles it takes to calculate a square root from 120 cycles on a PowerPC G4 to just 37 cycles on a PowerPC G5.
Enhanced Compiler

Apple has also supplied an enhanced compiler, GCC version 3.3, that generates optimal code for the Power Mac G5. The compiler produces code that executes efficiently on G5, G4, and G3 systems, so a single Mac OS X application runs optimally on each of Apple’s supported processor architectures, allowing developers to build and qualify a single version of their applications for both 32-bit and 64-bit Mac systems. In fact, Mac OS X Panther itself was completely recompiled using the GCC 3.3 compiler to achieve the best possible performance from the PowerPC G5.
Industry-Leading Performance

The Power Mac G5 is a revolutionary 64-bit desktop computer designed to meet
the high-performance, no-compromise requirements of today's most demanding
professional applications. With 64-bit power and a high-bandwidth architecture, this
groundbreaking system alleviates the limitations and bottlenecks of the traditional
PC—opening up a wealth of possibilities for 2D and 3D designers, video and audio
producers, scientists, researchers, and game developers and players.

Since the launch of the Power Mac G5 in June 2003, an increasing number of the
industry's most popular applications have been optimized for the Power Mac G5.
While existing 32-bit applications benefit from the faster processor and high-bandwidth
architecture, performance gains will be most dramatic with PowerPC
G5–optimized applications.

Apple put the Power Mac G5 to the test against the top-of-the-line competing systems.
Test results demonstrate its industry-leading performance in key application categories.
The industry's fastest frontside bus, an advanced system controller, and high-speed,
high-capacity memory combine to make the Power Mac G5 one of the fastest personal
computers ever built.

Film and Video

No matter what the format—DV, SD, HD, or film—the Power Mac G5 gives film and
video professionals the freedom and power to create studio-quality projects. The
faster G5 processor supports more simultaneous streams and real-time effects and
accelerates video processing and rendering. With cutting-edge applications like
Apple's Final Cut Pro HD, Motion, Shake, and DVD Studio Pro, and Alias Maya, you
can edit sequences, generate effects, composite scenes, author DVDs, and animate
characters in record time. The PowerPC G5 processor, driving a Mac OS X– and
QuickTime-based workflow, provides the flexibility to author in any format and XML
extensibility to share projects between applications. The Power Mac G5 also makes
it easy to build a state-of-the-art studio, with support for high-speed Xserve RAID
storage, a specialized PCI-X acquisition card, and high-performance FireWire 400
decks and devices.

Final Cut Pro HD

Final Cut Pro HD—Apple's high-performance nonlinear editing suite for professional
DV, SD, HD, and film editors—is optimized and accelerated for the Power Mac G5
and Mac OS X Panther. Taking full advantage of the speed, optimized Velocity Engine,
and multiple processors of the Power Mac G5, Final Cut Pro HD features RT Extreme,
an advanced multistream effects engine for digital video (DV), full-resolution uncom-
pressed SD video, and now DVCPRO HD.
Simultaneous video streams
Using Final Cut Pro HD, Apple tested the number of simultaneous video streams that could be played back on a Power Mac G5.

The dual 2.5GHz Power Mac G5 system can play up to 8 simultaneous SD video streams. The dual 2GHz and dual 1.8GHz Power Mac G5 systems can play up to 7 simultaneous SD video streams.

The dual 2.5GHz Power Mac G5 system can play up to 8 simultaneous SD video streams, compared with a maximum of 2 streams on the dual 1.42GHz Power Mac G4—the fastest Power Mac G4 Apple produced.

Testing conducted by Apple in May 2004 using preproduction dual 1.8GHz, 2GHz, and 2.5GHz Power Mac G5 units; the Power Mac G4 system was a production unit. All Power Mac systems were tested using Final Cut Pro HD and a single Xserve RAID configured with 512MB of RAM per controller, 14 drives, and RAID 50. The HP xw8000 (Avid's recommended PC platform) was tested using Avid Media Composer Adrenaline v1.3.1 and a six-disk (Avid rS73/320 MediaDrive, 10,000 rpm) RAID 0 volume connected via an LSI Logic dual-channel Ultra320 SCSI adapter.
Video rendering

Using Final Cut Pro HD on the Power Mac G5, Apple measured the time to render a 30-second uncompressed standard definition (SD) video clip with various commonly used effects and filters, including animated background texture with feathered alpha channel; four separate, scaled green-screen composites; and animated text with an alpha channel.

When rendering a complete project containing multiple effects and filters, the dual 2.5GHz, dual 2GHz, and dual 1.8GHz Power Mac G5 systems running Final Cut Pro HD were 28%, 13%, and 4% faster, respectively, than the dual Xeon-based system.

Testing conducted by Apple in May 2004 using preproduction dual 1.8GHz, 2GHz, and 2.5GHz Power Mac G5 units. The HP xw8000 was a production unit. Power Mac G5 systems were tested using Final Cut Pro HD. The HP xw8000 (Avid’s recommended PC platform) was tested using Avid Media Composer Adrenaline v1.3.1. All systems were tested using the internal disk subsystem.

Design and Print

The Power Mac G5 lets design and publishing professionals realize ideas as fast as they can imagine them. The blazing-fast G5 processor crunches through huge images and layouts, and with up to 8GB of memory, the Power Mac G5 enables instant access to large files and assets. The Serial ATA hard drive, built-in Gigabit Ethernet, and high-speed integrated I/O support provide high-bandwidth connections to printers, scanners, cameras, storage, networks, and more. The Quartz graphics engine in Mac OS X renders breathtaking content across mediums, and ColorSync ensures perfect color from capture to edit to output. You can even automate regular tasks with AppleScript to streamline your workflow. Publishing tools like Adobe Creative Suite and QuarkXPress, specially designed for Mac OS X and accelerated by the PowerPC G5 processor, will bring ideas to life in print or on the web.

Adobe Photoshop

To demonstrate the superiority of the Power Mac G5, Apple conducted tests using Adobe Photoshop CS (8.0), the most widely used application among creative professionals. Adobe Photoshop is a particularly effective cross-platform measure of system performance because it has been optimized for both Macintosh and Windows platforms.
Apple ran the tests using a 600MB Photoshop file and a suite of 45 commonly used Photoshop actions, including file saving, image adjustments, mode changes, and filters. Apple measured the time to execute each filter or function and compared the performance of all actions using an indexed score.

The dual 2.5GHz, dual 2GHz, and dual 1.8GHz Power Mac G5 systems ran the 45 filters 98%, 82%, and 66% faster, respectively, than the 3.4GHz Pentium 4–based system, and 75%, 63%, and 48% faster than the dual 3.2GHz Xeon–based system.

Testing conducted by Apple in May 2004 using preproduction dual 1.8GHz, 2GHz, and 2.5GHz Power Mac G5 units; all other systems were production units. File size = 600MB. For PC systems, cache sizes were: Dell Dimension XPS = 512K L2; Dell Precision 650 = 512K L2 per processor and 2MB L3 per processor; Alienware Aurora = 1MB L2.

Apple conducted the same tests on the Power Mac G4.

The dual 2.5GHz, dual 2GHz, and dual 1.8GHz Power Mac G5 systems ran the 45 filters 83%, 68%, and 54% faster, respectively, than the dual 1.42GHz Power Mac G4—the fastest Power Mac G4 Apple produced.

Testing conducted by Apple in May 2004 using preproduction dual 1.8GHz, 2GHz, and 2.5GHz Power Mac G5 units; the Power Mac G4 system was a production unit. File size = 600MB.
Bibble

Bibble is a powerful batch image processing application used by professional photographers for decoding files from native digital camera formats (such as Nikon’s .nef) into industry-standard formats (such as .tif). Bibble is a processor-intensive, multiprocessor-aware application that uses symmetric multiprocessing on the Mac and hyper-threading on the PC to enhance performance.

Apple tested the performance of the Power Mac G5 running MacBibble 3.1a. The test consisted of batch-converting 85 images from .nef to a 16-bit .tif format and measured how long each system took to complete the task.

<table>
<thead>
<tr>
<th>System</th>
<th>Percent faster than Pentium 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Mac G5</td>
<td>150% faster</td>
</tr>
<tr>
<td>Dual 2.5GHz PowerPC G5</td>
<td></td>
</tr>
<tr>
<td>Power Mac G5</td>
<td>119% faster</td>
</tr>
<tr>
<td>Dual 2GHz PowerPC G5</td>
<td></td>
</tr>
<tr>
<td>Power Mac G5</td>
<td>99% faster</td>
</tr>
<tr>
<td>Dual 1.8GHz PowerPC G5</td>
<td></td>
</tr>
<tr>
<td>Dell Precision 650</td>
<td>69% faster</td>
</tr>
<tr>
<td>Dual 3.2GHz Xeon</td>
<td></td>
</tr>
<tr>
<td>Alienware Aurora</td>
<td>6% faster</td>
</tr>
<tr>
<td>2.4GHz AMD Athlon 64 FX-53</td>
<td></td>
</tr>
<tr>
<td>Dell Dimension XPS</td>
<td>Baseline</td>
</tr>
<tr>
<td>3.4GHz Pentium 4</td>
<td></td>
</tr>
</tbody>
</table>

The dual 2.5GHz, dual 2GHz, and dual 1.8GHz Power Mac G5 systems decoded 85 images 150%, 119%, and 99% faster, respectively, than the 3.4GHz Pentium 4-based system, and 48%, 30%, and 18% faster, respectively, than the dual 3.2GHz Xeon-based system.

Testing conducted by Apple in May 2004 using preproduction dual 1.8GHz, 2GHz, and 2.5GHz Power Mac G5 units; all other systems were production units. Content size = 659MB. For PC systems, cache sizes were: Dell Dimension XPS = 512K L2; Dell Precision 650 = 512K L2 per processor and 2MB L3 per processor; Alienware Aurora = 1MB L2.

Music and Audio

With the new Power Mac G5, music and audio pros have even more power at their fingertips to compose, record, edit, mix, and perform. Dual PowerPC G5 processors effortlessly synthesize instruments and apply effects, and up to 8GB of memory provides ample room to compose using an unprecedented number of tracks. The built-in optical digital and analog audio ports support new and legacy hardware, and FireWire and USB ports let you connect to virtually any audio, MIDI, and storage device. Fast PCI-X provides expansion options for digital signal processing hardware solutions. Mac OS X with Core Audio allows you to run several applications simultaneously, while Audio Units provide a robust plug-in protocol designed to work seamlessly across Audio Units host applications. And with state-of-the-art applications like Emagic Logic Pro, Apple Soundtrack, Digidesign Pro Tools, MOTU Digital Performer, and Steinberg Cubase SX and Nuendo, you have a wealth of innovative software to capture your inspiration.
Logic Pro

To quantify the performance advantages of the Power Mac G5 for audio production, Apple tested Logic Pro 6.4.1. Apple created a processor-intensive workload containing multiple unique audio tracks, assigned five default reverb plug-ins to each audio track, and tested each platform to see which application could play more plug-ins.

The dual 2.5GHz, dual 2GHz, and dual 1.8GHz Power Mac G5 systems can play 180, 159, and 144 plug-ins, respectively, compared with a maximum of 42 plug-ins on the 3.4GHz Pentium 4–based system and 106 plug-ins on the dual 3.2GHz Xeon-based system.

Testing conducted by Apple in May 2004 using preproduction dual 1.8GHz, 2GHz, and 2.5GHz Power Mac G5 units; all other systems were production units. All Power Mac systems were tested using Logic Pro 6.4.1. The Dell Dimension XPS, Dell Precision 650, and Alienware Aurora were tested using Steinberg Cubase SX 2.0.1. For PC systems, cache sizes were: Dell Dimension XPS = 512K L2; Dell Precision 650 = 512K L2 per processor and 2MB L3 per processor; Alienware Aurora = 1MB L2.

Apple conducted the same test on the Power Mac G4.

The dual 2.5GHz, dual 2GHz, and dual 1.8GHz Power Mac G5 systems can play 180, 159, and 144 plug-ins, respectively, compared with a maximum of 60 plug-ins on the dual 1.42GHz Power Mac G4—the fastest Power Mac G4 Apple produced.

Testing conducted by Apple in May 2004 using preproduction dual 1.8GHz, 2GHz, and 2.5GHz Power Mac G5 units; the Power Mac G4 system was a production unit. All Power Mac systems were tested using Logic Pro 6.4.1.
Scientific and Technical Computing

The Power Mac G5 gives scientific researchers the ability to make discoveries in record time. Each 64-bit PowerPC G5 processor features two double-precision floating-point units and an optimized Velocity Engine that dramatically accelerates the computational power at hand. UNIX-based Mac OS X lets you run complex scientific applications and command-line tools alongside essential productivity applications, such as Microsoft Excel and Adobe Photoshop. You can develop custom applications while doing everyday work, all on the same computer and in the same operating system. Dual displays can be used to take advantage of the screen real estate of two systems to spread out windows and palettes to visualize more data. So whether you’re doing molecular modeling with PyMOL, searching for DNA alignments with BLAST, analyzing statistics with SPSS, modeling equations with Mathematica, or building your own programs with Apple’s Xcode tools, the power to get published fast is right in front of you.

HMMER

To demonstrate the performance advantages of the Power Mac G5 with Velocity Engine for processor-intensive scientific analysis, Apple used HMMER. This genome sequence–matching application uses Hidden Markov Models (HMMs) to identify similarities in genetic structures—a critical task in areas such as speech recognition and protein and DNA analysis. By representing the properties of a sequence family as a statistic, an HMM makes it possible to perform highly sensitive database searches.

The standard HMMER source code has been optimized for the Velocity Engine. The core routines of HMMER repeatedly perform the same operation on large amounts of data. Utilizing single-instruction, multiple-data (SIMD) technology, the Velocity Engine enables the application to perform the same operation on four pieces of data in a single clock cycle. With the optimized code, the performance of a HMMER search is now more than two times faster than with a 3.4GHz Pentium 4–based PC.

To test the performance of the HMMER code, Apple searched for an HMM created from a 358-residue sequence in the protein databank (PDB) and measured the time to search the entire PDB.

<table>
<thead>
<tr>
<th>Power Mac G5</th>
<th>Dual 2.5GHz PowerPC G5</th>
<th>129% faster</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dell Precision 650</td>
<td>Dual 3.2GHz Xeon</td>
<td>69% faster</td>
</tr>
<tr>
<td>Dell Dimension XPS</td>
<td>3.4GHz Pentium 4</td>
<td>Baseline</td>
</tr>
</tbody>
</table>

The dual 2.5GHz Power Mac G5 performed the HMMER search 129% faster than the 3.4GHz Pentium 4–based system, clearly demonstrating the advantages of the Velocity Engine and symmetric multiprocessing.

Testing conducted by Apple in May 2004 using preproduction dual 2.5GHz Power Mac G5 units; all other systems were production units. The Dell Dimension XPS and Dell Precision 650 ran HMMER on Red Hat Linux. For PC systems, cache sizes were: Dell Dimension XPS = 512K L2; Dell Precision 650 = 512K L2 per processor and 2MB L3 per processor.
3D Graphics

Today 3D graphics are everywhere—from high-end animation in motion pictures, TV, and games to detailed modeling for architecture, engineering, and scientific visualization—and in many cases, the Power Mac G5 is behind these creations. Even Mac OS X uses visual effects and real-time performance pioneered in 3D gaming to create the stunning look and feel of the Aqua interface. Whether you create graphics or enjoy them onscreen, the Power Mac G5 is the ideal platform for an impressive 3D experience.

Many powerful technologies are integrated into the Power Mac G5. The two double-precision floating-point units in each PowerPC G5 processor provide the computational power to calculate detailed scenery and complex visualizations. The AGP 8X Pro graphics interface allows graphics processors from ATI and NVIDIA to pump out higher frame rates than ever before. In addition, the graphics processors featured in the system offer all the latest technologies, such as multiple pixel pipelines, hardware transformation and lighting, and vertex and fragment programs, to create fantastic 3D experiences.

The Quartz Extreme feature of Mac OS X leverages the power of the graphics processors even further by offloading the OpenGL and QuickTime multimedia work of the Quartz Compositor, thus freeing up the main processor for other tasks. All of these technologies combined open the door for amazing 3D applications.

Impressive 3D graphics across the board

Professionals in multiple disciplines use the Mac for their 3D workflows. New versions of 3D applications leverage both the PowerPC G5 and today’s high-performance graphics cards to enable real-time 3D performance. Popular 3D creative applications such as Maya, Cinema 4D, LightWave, and MOTIONBUILDER are all available on the Mac platform. Architects and engineers have ArchiCAD, VectorWorks, FormZ, SketchUp, Designer Elements, and more at their fingertips. And for scientific visualization, molecular modeling applications such as DeLano Scientific’s PyMOL, a UNIX application, are available for the first time ever on the Mac.

3D gaming

3D gaming involves complex visualizations and rapid movements that require maximum processor performance and top-of-the-line graphics capabilities. The Power Mac G5 provides a robust platform that not only supports the latest 3D technologies, but also delivers a great gaming experience. Using the latest graphics interface, AGP 8X Pro, the Power Mac G5 combines superfast graphics performance and 64-bit G5 processors to deliver more frames per second at higher resolutions—all with more complexity and better texturing than ever before.

3D rendering

LightWave 3D is a popular digital content creation application that includes a fast rendering engine. Its capabilities are proven in film, television, and gaming, and it is also used for creating graphics for print and the web—anywhere 3D content is needed. To demonstrate the performance of the Power Mac G5, Apple rendered a scene using LightWave 3D and measured the time it took each system to complete the task.
The dual 2.5GHz Power Mac G5 was 104% faster than the 3.4GHz Pentium 4–based system and 24% faster than the dual 3.2GHz Xeon-based system.

Testing conducted by Apple in May 2004 using preproduction dual 1.8GHz, 2GHz, and 2.5GHz Power Mac G5 units; all other systems were production units. Benchmark scene = Skull_Head_Newest. For PC systems, cache sizes were: Dell Dimension XPS = 512K L2; Dell Precision 650 = 512K L2 per processor and 2MB L3 per processor; Alienware Aurora = 1MB L2.

Apple conducted the same test on the Power Mac G4.

The dual 2.5GHz, dual 2GHz, and dual 1.8GHz Power Mac G5 systems were 80%, 43%, and 30% faster, respectively, than the dual 1.42GHz Power Mac G4—the fastest Power Mac G4 Apple produced.

Testing conducted by Apple in May 2004 using preproduction dual 1.8GHz, 2GHz, and 2.5GHz Power Mac G5 units; the Power Mac G4 system was a production unit. Benchmark scene = Skull_Head_Newest.

For details about these and other performance tests, see www.apple.com/powermac/performance.
Product Configurations and Options

Why buy a Power Mac G5?

- The 64-bit PowerPC G5 accelerates all types of applications, thanks to clock speeds of up to 2.5GHz, an optimized Velocity Engine, and two double-precision floating-point units.
- With the industry’s fastest frontside bus and high-speed, high-capacity memory, applications rip through work faster than ever before.
- Whether you’re at work or at play, you’ll enjoy eye-popping graphics, especially on one of Apple’s stunning flat-panel LCD displays.
- Apple’s most expandable Mac provides high-bandwidth connections for a full range of industry-standard, high-performance peripherals.
- An innovative enclosure design uses a superefficient thermal zone scheme and low-speed fans to stay cool and quiet.
- Mac OS X runs state-of-the-art professional applications and protects existing software investments for a seamless transition to 64-bit computing.

Standard Configurations

Apple offers Power Mac G5 systems to meet the needs of professionals, media producers, educators, researchers, and businesspeople. The following standard configurations are available through the Apple Store and Apple Authorized Resellers.

<table>
<thead>
<tr>
<th>Order number</th>
<th>M9454LL/A</th>
<th>M9455LL/A</th>
<th>M9457LL/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor</td>
<td>Dual 1.8GHz PowerPC G5</td>
<td>Dual 2GHz PowerPC G5</td>
<td>Dual 2.5GHz PowerPC G5</td>
</tr>
<tr>
<td>L2 cache</td>
<td>512K per processor</td>
<td>512K per processor</td>
<td>512K per processor</td>
</tr>
<tr>
<td>Frontside bus</td>
<td>900MHz per processor</td>
<td>1GHz per processor</td>
<td>1.25GHz per processor</td>
</tr>
<tr>
<td>Main memory</td>
<td>256MB of PC3200 (400MHz) DDR SDRAM; supports up to 4GB</td>
<td>512MB of PC3200 (400MHz) DDR SDRAM; supports up to 8GB</td>
<td>512MB of PC3200 (400MHz) DDR SDRAM; supports up to 8GB</td>
</tr>
<tr>
<td>Graphics</td>
<td>NVIDIA GeForce FX 5200 Ultra with 64MB of DDR SDRAM</td>
<td>NVIDIA GeForce FX 5200 Ultra with 64MB of DDR SDRAM</td>
<td>ATI Radeon 9600 XT with 128MB of DDR SDRAM</td>
</tr>
<tr>
<td>Hard drive</td>
<td>80GB Serial ATA</td>
<td>160GB Serial ATA</td>
<td>160GB Serial ATA</td>
</tr>
<tr>
<td>PCI slots</td>
<td>Three open full-length 33MHz, 64-bit PCI slots</td>
<td>Three open full-length PCI-X slots: one 133MHz, 64-bit slot and two 100MHz, 64-bit slots</td>
<td>Three open full-length PCI-X slots: one 133MHz, 64-bit slot and two 100MHz, 64-bit slots</td>
</tr>
<tr>
<td>Expansion</td>
<td>One FireWire 800 port, two FireWire 400 ports (one on front); three USB 2.0 ports (one on front), two USB 1.1 ports (on keyboard); AGP 8X Pro slot with graphics card installed, including ADC connector and DVI connector; two internal hard drive bays (one occupied)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Audio</td>
<td>Optical digital audio input, optical digital audio output, analog audio input, analog audio output, front headphone minijack and speaker</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Networking</td>
<td>10/100/1000BASE-T Ethernet, 56K V.92 modem, AirPort Extreme ready, Bluetooth option</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Software</td>
<td>Mac OS X, Mail, iChat AV, Safari, Sherlock, Address Book, QuickTime, Life (includes iTunes, iPhoto, iMovie, iDVD, and GarageBand), iSync, iCal, DVD Player, Classic environment, Art Directors Toolkit, EarthLink TotalAccess 2004 (includes 30 days of free dial-up Internet service with EarthLink activation), GraphicConverter, OmniGraffle, OmniOutliner, QuickBooks for Mac New User Edition, Zinio Reader, Xcode Developer Tools</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service and support</td>
<td>90 days of free telephone support and one-year limited warranty</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Also included</td>
<td>Apple Keyboard, Apple Mouse, USB keyboard extension cable, DVI to VGA adapter, modem cable, AirPort antenna</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Build-to-Order Options

Order a custom-configured computer from the Apple Store or an Apple Authorized Reseller. Build-to-order options can include the following:

- Memory (PC3200 DDR SDRAM; installed in pairs): 256MB, 512MB, 1GB, 2GB, 4GB, 8GB
- Hard drives (Serial ATA): 80GB, 160GB, 250GB
- Optical drive: SuperDrive (DVD-R/CD-RW), Combo drive (DVD-ROM/CD-RW)
- Graphics: NVIDIA GeForce FX 5200 Ultra with 64MB of DDR SDRAM, ATI Radeon 9600 XT with 128MB of DDR SDRAM, ATI Radeon 9800 XT with 256MB of DDR SDRAM (Radeon 9800 XT occupies AGP slot and adjacent PCI slot)
- Wireless: AirPort Extreme Card, AirPort Extreme Base Station, Bluetooth module with antenna
- External storage: Xserve RAID and Apple Fibre Channel PCI Card
- Gigabit Ethernet PCI-X Card

Apple Displays and Adapters

To complete your Power Mac G5 system, you can choose from Apple’s family of all-digital, flat-panel displays.

- Apple Studio Display (17-inch flat panel), order number M7649ZM/B
- Apple Cinema Display (20-inch flat panel), order number M8893ZM/A
- Apple Cinema HD Display (23-inch flat panel), order number M8537ZM/A
- Apple DVI to ADC Adapter (for connecting a second Apple display), order number M8661LL/A
- Apple DVI to Video Adapter (for connecting S-video or composite devices), order number M9267G/A

Other Products

These products are available to enhance your Power Mac G5 system.

- Audio: Apple iPod, iPod mini, Logitech Z-680 5.1 speakers, Klipsch ProMedia GMX D-5.1 speakers, Toslink optical digital cables
- Mac OS X Server
- DVD-R Media Kit

Extended Service and Support

Purchase the AppleCare Protection Plan to extend your service and support to up to three full years. The plan provides support for your Mac, the Mac OS, and many Apple consumer applications, so just one phone call can help resolve most issues. You can also enroll one Apple display for coverage, provided that your Power Mac G5 and display are purchased together.

For more information, visit www.apple.com/support/products or call 800-823-2775.
Technical Specifications

Processing
- Dual 1.8GHz, dual 2GHz, or dual 2.5GHz 64-bit PowerPC G5 microprocessors
- PowerPC processor architecture with 64-bit data paths and registers
- Native support for 32-bit application code
- 512K on-chip L2 cache running at processor speed
- Parallel data structure supporting up to 215 simultaneous in-flight instructions
- Simultaneous issue of up to 10 out-of-order operations
- Dual-pipeline Velocity Engine for 128-bit single-instruction, multiple-data (SIMD) processing
- Two independent double-precision floating-point units
- Advanced three-component branch prediction logic
- 900MHz, 1GHz, or 1.25GHz 64-bit DDR frontside bus supporting up to 10-GBps data throughput; one on each processor
- Point-to-point system controller

Memory
- 128-bit data paths for up to 6.4-GBps memory throughput
- Dual 1.8GHz systems:
  - 256MB of PC3200 (400MHz) DDR SDRAM
  - Four DIMM slots supporting up to 4GB of main memory
- Dual 2GHz and dual 2.5GHz systems:
  - 512MB of PC3200 (400MHz) DDR SDRAM
  - Eight DIMM slots supporting up to 8GB of main memory
- Support for the following DIMMs (in pairs):
  - 128MB DIMMs (64-bit-wide, 128- or 256-Mbit)
  - 256MB DIMMs (64-bit-wide, 128- or 256-Mbit)
  - 512MB DIMMs (64-bit-wide, 256-Mbit)
  - 1GB DIMMs (64-bit-wide, 256-Mbit)

Graphics and displays
- AGP 8X Pro graphics slot supporting up to 2-GBps data throughput, with one of the following graphics cards installed:
  - NVIDIA GeForce FX 5200 Ultra with 64MB of DDR SDRAM
  - ATI Radeon 9600 XT with 128MB of DDR SDRAM
  - ATI Radeon 9800 XT with 256MB of DDR SDRAM (build-to-order option; occupies AGP slot and adjacent PCI slot)
- Support for digital resolutions up to 1920 by 1200 pixels
- Support for analog resolutions up to 1600 by 1200 pixels
- ADC and DVI connectors; DVI to VGA adapter included
- Dual display support for extended desktop and video mirroring modes
- Support for up to two Apple flat-panel displays

Technology and Performance Overview
Power Mac G5
Storage
- Two 3.5-inch hard drive bays, each with a 150-MBps Serial ATA controller; one of the following is installed:
  - One 80GB 7200-rpm Serial ATA; 8MB memory buffers
  - One 160GB 7200-rpm Serial ATA; 8MB memory buffers
  - One or two 250GB 7200-rpm Serial ATA; 8MB memory buffers (build-to-order option)
- Optical drive bay with SuperDrive (DVD-R/CD-RW) installed; writes DVD-R discs at up to 8x speed, reads DVDs at up to 10x speed, writes CD-R discs at up to 24x speed, writes CD-RW discs at up to 10x speed, reads CDs at up to 32x speed

PCI expansion
- Dual 1.8GHz systems:
  - Three open full-length 33MHz, 64-bit PCI slots
- Dual 2GHz and dual 2.5GHz systems:
  - One open full-length 133MHz, 64-bit PCI-X slot and two open full-length 100MHz, 64-bit PCI-X slots

Communications
- 10/100/1000BASE-T Ethernet (RJ-45)
- Built-in 56K V.92 modem (RJ-11)<sup>9</sup>
- Expansion slot for optional 54-Mbps AirPort Extreme Card (based on IEEE 802.11g standard; Wi-Fi Certified for 802.11g and 802.11b interoperability)<sup>4</sup>
- External AirPort Extreme antenna
- Optional Bluetooth 1.1 module and antenna

Peripherals and audio
- One FireWire 800 port; two FireWire 400 ports (one on front panel; 15W total power)
- Three USB 2.0 ports (one on front panel), two USB 1.1 ports on keyboard
- Front headphone minijack and speaker
- Optical digital audio input and output Toslink connectors
- Stereo audio input and output minijacks

Electrical and environmental requirements
- Meets ENERGY STAR requirements
- Line voltage: 100–125V AC or 200–240V AC
- Frequency: 50Hz to 60Hz, single phase
- Maximum current: 6.5A (low-voltage range) or 7.5A (high-voltage range)
- Operating temperature: 50° to 95° F (10° to 35° C)
- Storage temperature: –40° to 116° F (–40° to 47° C)
- Relative humidity: 5% to 95% noncondensing
- Maximum altitude: 10,000 feet

Size and weight
- Height: 20.1 inches (51.1 cm)
- Width: 8.1 inches (20.6 cm)
- Depth: 18.7 inches (47.5 cm)
- Weight: 44.4 pounds (20.2 kg)<sup>10</sup>
Internet access requires a compatible Internet service provider; fees may apply. Product contains electronic documentation. Backup copy of software is included. \(^1\)Testing conducted by Apple in May 2004 using preproduction dual 1.8GHz, 2GHz, and 2.5GHz Power Mac G5 units; all other systems tested were shipping units. \(^2\)Selected models. \(^3\)1GB = 1 billion bytes; actual formatted capacity less. \(^4\)Wireless Internet access requires AirPort Extreme Card, wireless access point, and Internet access (fees may apply). Achieving data rates up to 54 Mbps requires that all users have an AirPort Extreme Card and connect to an AirPort Extreme Base Station. Some ISPs are not compatible with AirPort and AirPort Extreme. Range may vary with site conditions. \(^5\)Check with manufacturer for compatibility. \(^6\)Second Apple flat-panel display requires Apple DVI to ADC Adapter, sold separately. \(^7\)Occupies the AGP slot and adjacent PCI slot. \(^8\)Actual rates will vary. \(^9\)Compatible ISP and telephone services required. Your ISP may not support all V.92 features. Modem will function according to V.90 standards if V.92 services are not available. Actual modem speeds lower. \(^10\)Weight varies by configuration and manufacturing process.

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For More Information

For more information about the Power Mac G5, visit www.apple.com/powermac.