Power Mac G4

Technology Overview
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Introduction

Faster, more expansive, and more affordable than ever, the new Power Mac G4 is the ultimate system for any digital pro.

With dual processors up to 1.42GHz, this is the fastest Mac ever. But processor speed is only part of the story. Unlike Pentium-based computers, the Power Mac G4 features a highly efficient, low-latency architecture carefully designed so all hardware components and the system software work together seamlessly for optimum performance. That's what enables Power Mac systems to outperform Pentium-based computers on the tasks that are most important to digital media professionals.

What else is new in the Power Mac G4? FireWire, the industry-standard high-speed I/O technology developed by Apple, is now twice as fast as before. The new FireWire 800 port lets you connect the latest generation of FireWire 800 peripheral devices to achieve speeds up to 800 Mbps.[1]

The Power Mac G4 also supports AirPort Extreme, the new wireless networking solution from Apple that's based on the proposed IEEE 802.11g standard. Just add an AirPort Extreme Card to the computer, and it can connect to an AirPort Extreme Base Station or another AirPort Extreme–equipped Mac at speeds up to 54 Mbps. That's nearly five times as fast as the data transfer rates of the current AirPort (802.11b) technology. AirPort Extreme is compatible with AirPort and other 802.11b devices.[2]

Also new in standard or build-to-order configurations of the Power Mac G4 are a faster SuperDrive for reading and writing CDs and DVDs,[3] internal hard drives up to 180GB,[4] Bluetooth wireless device connectivity, and the amazingly fast ATI Radeon 9700 Pro graphics processor.

Reliable, UNIX-based Mac OS X accelerates application performance with powerful symmetric multiprocessing and multithreading capabilities. And its composited windowing system, Quartz Extreme, seamlessly blends 2D, 3D, and video content for vastly improved graphics performance.

With its high-performance architecture, massive expansion, leading-edge graphics and displays, powerful synergy with Mac OS X, and included software, the Power Mac G4 is the ultimate digital media powerhouse for creative departments, audio and video pro-duction studios, research centers, educational institutions, and businesses everywhere.

Product Overview

The Power Mac G4 features a low-latency, Xserve-based architecture that has been optimized to meet the needs of the most demanding desktop computer users. The new models include dual processors up to 1.42GHz, a faster SuperDrive, and optional AirPort Extreme and Bluetooth wireless connectivity.

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6	SuperDrive[3] and second optical drive bay		
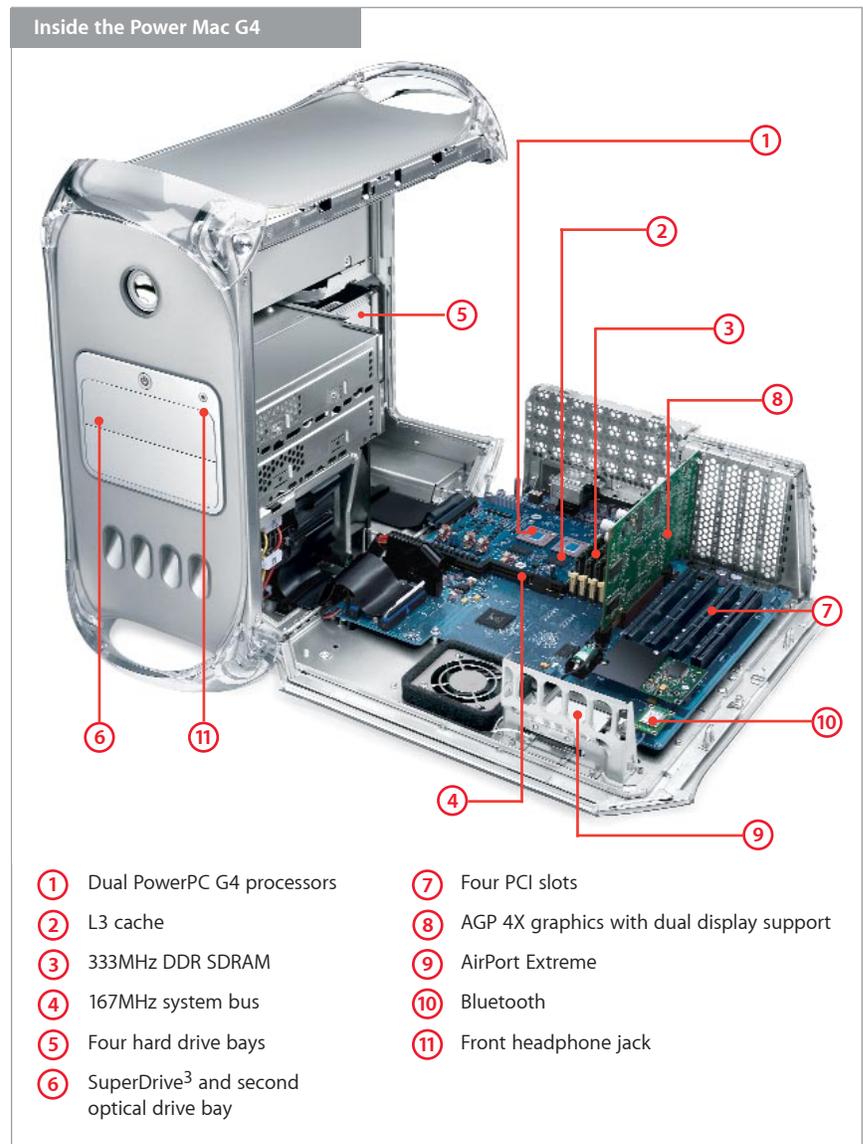
On the cutting edge of technology, the Power Mac G4 includes myriad input/output options for connecting to high-speed networks and peripheral devices. A FireWire 800 port is included in all new models.

Connecting to the Power Mac G4

DVI port

ADC port

USB (two)

FireWire 400 (two)

FireWire 800

10/100/1000BASE-T Ethernet

Audio line in

Apple speaker minijack

Audio line out

56K V.92 modem[5]

High-Performance Dual Processor Xserve-Based Architecture

For the ultimate in computing power, all Power Mac G4 systems are based on the highly acclaimed Apple Xserve architecture. It combines one or two PowerPC G4 processors, Double Data Rate (DDR) main memory, dedicated L3 cache, and integrated high-speed I/O for efficient processing and high system throughput.

Efficient PowerPC G4 Processing

The PowerPC G4 processor has been intelligently designed for maximum efficiency and performance. It can accomplish more work than its competitors in the same amount of time because of its short pipeline and the parallel processing Velocity Engine.

Short pipeline
All processors complete their tasks in a series of stages referred to as the processor "pipeline." Examples of stages include fetching data, decoding data, executing instructions, and storing data.

The PowerPC G4 processor was designed with a short 7-stage pipeline, while the Pentium 4 processor has 20 stages. Because of its shorter pipeline, the more efficient PowerPC G4 can accomplish the same task in 13 fewer steps than the Pentium 4.

Its short processor pipeline also enables the PowerPC G4 to adapt more quickly to changing conditions. All advanced processors try to increase performance by guessing what they'll need to do next. This is called speculative operation. Of course, the processor doesn't always guess correctly. When it's wrong, it has to clear the pipeline and start over. These periods of time when no data is available for processing are known as bubbles. Because the PowerPC G4 pipeline is short, the processor can recover from bubbles and resume getting data to the processor very quickly. With fewer processing steps, faster recovery, and higher utilization, processor output is maximized.

Velocity Engine
The PowerPC G4 processor further improves efficiency with a specialized 128-bit vector processing unit called the Velocity Engine. The Velocity Engine uses SIMD (Single Instruction Multiple Data) technology, which allows application of a single instruction to multiple data at the same time to accelerate data processing.

Software programs that use vector processing typically transform large sets of data as they edit an image or render a video effect. For example, when a filter is used to apply a motion blur to an image, each pixel of the image must be changed according to the same set of instructions—a highly repetitive processing task. The Velocity Engine accelerates this task by modifying the image in chunks as large as 128 bits at a time. And because it's a separate processing unit, the Velocity Engine can work on an intensive task while the other functional units in the processor are busy crunching other data.

Because of the efficiencies of its short pipeline and Velocity Engine, the PowerPC G4 can often accomplish work in the same amount of time as a Pentium 4 that has a nominally faster clock speed. On some tasks of special interest to digital media professionals, the PowerPC G4 is even faster.

Advanced Low-Latency System Design

Optimum performance demands efficient operation from all aspects of the system architecture. The Power Mac G4 is designed for fast response (low latency), even with the high volume of system traffic required for complex processing. The major features of this design include an L3 cache, a fast system bus, DDR main memory, dual ATA hard drive controllers, a direct PCI bus, and integrated high-speed I/O controllers.

Power Mac G4 Architecture
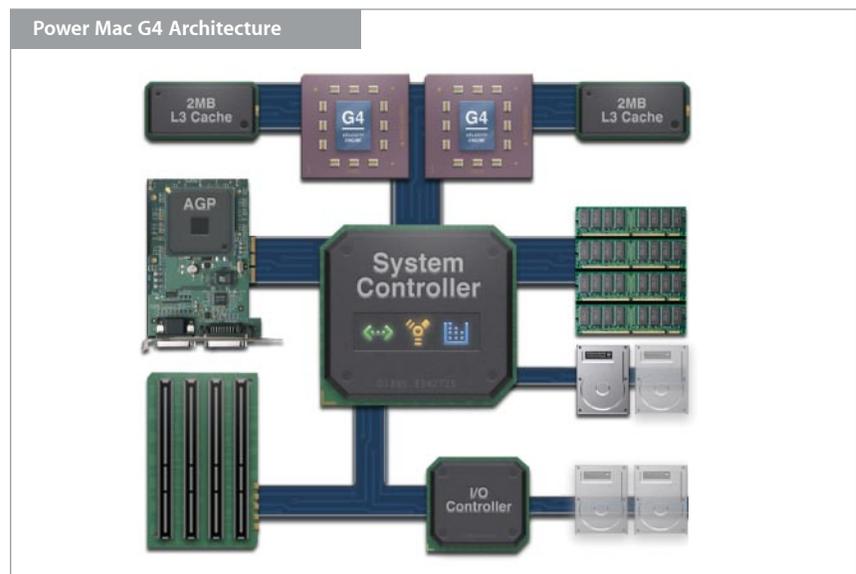
L3 cache
An efficient processor alone doesn't guarantee results with real-world applications. The system architecture needs to make the most of the processor's computing power by providing fast access to the data and application code it uses. The Power Mac G4 maximizes the efficiency of the PowerPC G4 processor through its unique L3 cache memory architecture.

In standard computer architecture, the processor accesses data from the hard drive and main memory. It takes a long time to get data from the hard drive, while accessing data from main memory is significantly faster—which is why users working with large data sets prefer to equip their systems with more RAM. The Power Mac G4 architecture takes this concept one step further with an even faster level of memory called L3 cache, a feature of many high-end servers not normally found in desktop PCs.

L3 cache is high-speed Double Data Rate SRAM memory. It provides fast access to data and application code, because it has a dedicated bus to the processor, providing throughput of up to 4 GBps with no bottlenecks caused by other data transfers. The high speed of L3 cache, with its dedicated bus, allows the processor to receive data more than five times faster than from main memory, with its lower speed and shared bus. Because of this low latency, the processor is constantly fed with data—so it doesn't sit idle, waiting for the next set of data to arrive. Each processor in the new Power Mac G4 has its own L3 cache, so the two processors in the dual processor models share data seamlessly with each other without pausing to update main memory.

With up to 2MB of dedicated memory, the L3 cache can store large portions of active application code and data. When a user runs an application, most of the active program code and user data is in the L3 cache. This keeps the most important information close to the processor and quickly accessible. (The concept is similar to caching web pages on the hard drive. If you click the Back button on your web browser, your computer will use the data you recently downloaded, rather than loading the same data from the Internet again.) In contrast, in standard PC architecture, data travels from main memory to the processor through the system controller, where data and instructions from other subsystems are also moving. Congestion among these various data streams causes slowdowns in the overall transfer rate, which in turn hampers application performance.

The table below illustrates the kind of performance benefits that L3 cache can offer. In this test, we compared the miss latency of Power Mac G4 and Pentium 4–based systems by running Calibrator, a tool that analyzes a computer's cache memory system and extracts parameters such as number of cache levels, size, and access/miss latency. "Miss latency" refers to the time needed for a processor to find data in its various caches or in main memory. A processor looks first to its L1 cache. If the required data does not reside in L1, it moves on to L2, then to L3 (if available), and finally to main memory. Each step at which the processor does not find the required data is called a "miss," and each data search takes a certain amount of time, or "latency." The smaller the latency, the faster the system performance.

Latency to main memory comparison

L1 cache miss latency	Nanoseconds
Power Mac G4	5 ns
3GHz Pentium 4	10.1 ns

L2 cache miss latency	Nanoseconds
Power Mac G4	23.3 ns
3GHz Pentium 4	135.8 ns

L3 cache miss latency	Nanoseconds
Power Mac G4	64.1 ns
3GHz Pentium 4	No L3 cache available

Total time to main memory	Nanoseconds
Power Mac G4	94.5 ns
Pentium 4	146.6 ns

Shorter bars indicate lower latency, and thus faster access to data. The Power Mac G4 system tested had dual 1.42GHz processors, 64K of L1 cache, 256K of L2 cache, and 2MB of L3 cache. The Pentium 4–based system had a 3GHz processor, 20K of L1 cache, 512K of L2 cache, and no L3 cache. Tests were performed by Apple in January 2003.

In the Power Mac G4, the large, fast L3 cache substantially decreases the time it takes the processors to find data. In this example, the time required to look through the caches and access main memory was only 95 nanoseconds (ns) on the Macintosh system versus 147 nanoseconds on the Pentium system—55 percent faster on the Mac. This is just one example of how the overall system design of the Power Mac G4 enables it to outperform Pentium-based computers whose processors run at higher speeds.

Fast system controller
The system controller, first introduced in the Xserve, coordinates and transfers data and instructions among the processor(s), PCI bus, memory, graphics, and I/O buses of the Power Mac G4. Controller speeds in Power Mac G4 configurations run as high as 167MHz.

Double Data Rate (DDR) main memory
Power Mac G4 systems feature Double Data Rate synchronous dynamic random access memory (DDR SDRAM), which allows the system to read and write data to and from memory on both the rising and falling edge of each clock cycle. It provides twice the throughput of Single Data Rate (SDR) SDRAM, which reads and writes data only on the rising edge of the clock cycle. The resulting throughput between main memory and the system controller is 2.7 GBps. DDR SDRAM increases memory bandwidth not only to the processors, but also to all elements of the system. Direct memory access (DMA) allows system elements, such as a hard drive controller or a graphics processing unit, to send and receive data directly from main memory, without going through the processors. The added memory bandwidth allows system elements to function independently at high data rates, boosting total system performance.

Dual ATA hard drive controllers
The Power Mac G4 includes one ATA/100 bus and one ATA/66 bus. All standard configurations ship with one 7200-rpm hard drive on the ATA/100 bus. For faster throughput, if you add a second drive, it's best to put it on the ATA/66 bus. For maximum storage bandwidth, you can install two drives on each bus.

In addition, the RAID functionality in Mac OS X allows multiple hard drives to be striped for faster performance or mirrored for data redundancy.

Direct PCI bus
The Power Mac G4 optimizes PCI performance by having the PCI bus connected directly to the system controller.

In a typical PC architecture, PCI devices connect to the I/O controller through a bridge, a stage in the data path where all connected PCI devices are slowed down to avoid overloading the system controller. Going through this bridge constrains PCI throughput to 133 MBps, even with otherwise fast PCI devices. This slowdown of data to and from PCI devices results in greater overall system latency.

In contrast, the direct 266-MBps bus to the PCI slots on the Power Mac G4 guarantees high throughput and low congestion, thereby decreasing latency. The Power Mac G4 also supports write combining, which allows write instructions to be grouped into one large instruction, further increasing data throughput.

Integrated high-speed I/O
FireWire and Gigabit Ethernet are high-performance technologies for connecting a computer to the latest peripherals and high-speed networks.

On PCs, these features are often acquired through PCI cards. This approach takes up valuable PCI slots and causes additional data congestion for the PCI bus and I/O controller.

On the Power Mac G4, FireWire, Gigabit Ethernet, and even the ATA/100 bus are built into the system and integrated directly into the system controller. (The ATA/66 bus has its own controller.) This dedicated connection reduces PCI congestion and guarantees low latency, resulting in optimal FireWire, Ethernet, and hard drive performance. It also keeps the computer's PCI slots free for more specialized cards instead of using the slots to provide basic capabilities.

Massive Expansion

The Power Mac G4 is designed for maximum expansion to give you the flexibility to create a system that's ideal for your most demanding work. The swing-open side door provides quick access to slots and bays, making it easy to add specialized capabilities. Adding drives or memory and installing an AirPort Extreme wireless networking card, for example, are trivial tasks. And you can connect fast, powerful peripherals using the built-in FireWire and USB ports.

Mac OS X is designed to integrate external devices into the computing experience seamlessly, so you can "plug and play" devices instead of spending your time figuring out how to make the system work. For example, the icon for a FireWire hard drive appears on the desktop as soon as the drive is connected, and iPhoto automatically opens when a digital camera is plugged in. In addition, the Rendezvous technology in Mac OS X v10.2 can instantly discover Rendezvous-enabled printers, wireless networks, and other resources.

Four Open PCI Slots

All Power Mac G4 models feature four unoccupied full-length 64-bit, 33MHz PCI slots, so it's easy to add multiple PCI cards for specialized high-performance tasks. For example, recording artists depend on digital audio cards for music production tools, and filmmakers often fill PCI slots with video capture cards, signal processor cards, and SCSI cards.

DDR SDRAM Memory Up to 2GB

The Power Mac G4 is designed to accommodate four memory DIMMs for up to 2GB of main memory.[6] Many graphics and video applications, for example, show significant performance improvements with larger memory configurations. The speed of the memory is dependent on which Power Mac G4 model is used. A system with a 133MHz system bus uses PC2100 or 266MHz memory, while a Power Mac G4 with a 167MHz system bus uses PC2700 or 333MHz memory.

Four Internal Hard Drive Bays

For the greatest flexibility in internal storage, the Power Mac G4 comes with dual ATA buses: one ATA/100 bus and one ATA/66 bus. A single ATA/100 hard drive is preinstalled, with the cabling to connect a second hard drive. The ATA/66 bus can also connect to two hard drives; all the necessary power and data connectors for the ATA/66 bus are preinstalled in the Power Mac G4. Using all four drive bays, the Power Mac G4 supports up to 720GB of internal storage—nearly three-fourths of a terabyte of information.

With a third-party solution, the Power Mac G4 also supports SCSI drives in any or all of the four drive bays. Mac OS X includes built-in RAID support, so you can use multiple hard drives for mirroring for data redundancy, or for striping to increase drive throughput.

Two Optical Drive Bays

All Power Mac G4 systems include two optical drive bays. One optical drive is included with every system—users can choose the SuperDrive (DVD-R/CD-RW) or a Combo drive (DVD-ROM/CD-RW). A second full-height optical drive bay makes it easy to install an additional high-speed optical drive for added reading and writing capabilities. Drive speeds have been dramatically increased, so users can record DVDs and CDs twice as fast as with previous models.

SuperDrive (DVD-R/CD-RW)
Authoring CD and DVD media is fast and easy with the SuperDrive, a combination DVD-R and CD-RW drive.[3] Disc burning with the SuperDrive is integrated into Apple applications such as iDVD, DVD Studio Pro, and iTunes. You can also archive data to CD and DVD right from the Finder.

The SuperDrive is an industry-standard drive that reads dozens of standard CD and DVD formats—and the latest model burns discs twice as fast as before. It now writes DVD-R discs at 4x speed, reads DVDs at 8x speed, writes CD-R discs at 16x speed, writes CD-RW discs at 8x speed, and reads CDs at 32x speed. It's the easiest way to author CDs and DVDs for use in most professional or consumer players.

The SuperDrive is also ideal for backup. CDs can hold up to 700MB of data, more than 480 times as much as a floppy disk. DVDs can store 4.7GB of data, the equivalent of about 7 CDs, 18 Zip 250 disks, or 3200 floppy disks. With this kind of capacity, you can easily back up your entire digital photo collection or 1000 MP3 files—and keep them safe for years.

High-Speed I/O

The Power Mac G4 brings faster FireWire connectivity to the Power Mac line, as well as an additional FireWire port. Of course, you also get four USB ports (two on the system, two on the keyboard) for attaching your favorite USB devices.

FireWire 800
FireWire—a technology developed by Apple—is the industry standard for connecting peripheral devices such as DV camcorders and hard drives that require high-bandwidth data exchange. FireWire is easy to use, operates in real time, and includes cross-platform, industry-standard device interoperability. It's also almost unlimited in its versatility, allowing you to connect as many as 63 devices to each FireWire bus.

The original version of FireWire (also known as IEEE 1394) supported data transfer rates up to 400 Mbps. Now Apple has introduced FireWire 800, the next generation of this high-performance technology. FireWire 800 can transfer twice the amount of data in the same time as FireWire 400, effectively doubling data throughput.[1] When you're working with multiple FireWire devices—such as hard drives and a DV camera— simultaneous performance is also improved.

FireWire 800 works over distances of up to 100 meters, making it ideal for connecting high-speed, self-powered devices that function at some distance from the computer, such as video cameras and microphones for studio or surveillance applications.

USB versus FireWire

Bus	Theoretical maximum speed in Mbps
USB 1.1	12
FireWire 400	400
USB 2.0	480
FireWire 800	800

Due to the speed and efficiencies of FireWire 800, in many cases the effective bandwidth is nearly twice that of USB 2.0.

The added speed and longer cable distance of FireWire 800 come from two major improvements to the underlying technology. First is a new, highly efficient arbitration scheme for the devices sharing a given FireWire bus. Arbitration determines when the devices get to transmit. In FireWire 800, the arbitration for the next transaction is done while the current data packet is being sent, so the device chosen by the arbitration is ready to send its data as soon as the current transmission finishes. The second improvement is the use of advanced data encoding that results in less signal distortion, and therefore enables higher throughput.

The Power Mac G4 is equipped with one FireWire 800 port and two FireWire 400 ports. The 800-Mbps port has a 9-pin connector and, with the appropriate cable, works with original FireWire devices that use 6-pin or 4-pin connectors. Cables are available (from the Apple Store and other sources) for connecting the 9-pin port to 4-pin, 6-pin, and 9-pin devices. On the Power Mac G4, FireWire provides up to 15 watts of power to charge external devices, such as Apple's iPod digital music player.

FireWire has rapidly become the interface of choice for digital video camcorders, high-performance external disk drives, professional-quality printers, and other high-speed peripherals. In fact, Apple won a technical excellence Emmy award for FireWire because of its value to video professionals.

For more information about FireWire 800, visit www.apple.com/firewire.

USB
The Power Mac G4 includes two 12-Mbps USB ports in the rear I/O panel, two USB ports on the keyboard, and two more USB ports on Apple flat-panel displays. Users can connect a wide variety of USB-based printers, keyboards, microphones, speakers, and digital cameras to the Power Mac G4 with plug-and-play convenience. For example, website designers can connect as many input devices, such as a graphics tablet or removable media devices, as they need. For more information about USB technology, visit www.apple.com/usb.

Wired and Wireless Networking

With the Power Mac G4, you can connect to networks however you want. A 56K modem[5] and 10/100/1000BASE-T Ethernet are built in, and AirPort Extreme and Bluetooth wireless networking are available as options.

Gigabit Ethernet
Standard on all Power Mac G4 systems, Gigabit Ethernet provides a theoretical raw data bandwidth of 1000 Mbps, or 1 gigabit per second. Gigabit (10/100/1000BASE-T) Ethernet is based on the IEEE 802.3ab standard. On Mac systems, Gigabit Ethernet resides on the logic board rather than on a PCI card, as is typical of Pentium-based systems. With Mac OS X, users gain the added benefit of an advanced I/O operating system architecture and standards-based BSD networking.

Gigabit Ethernet uses Category 5 and 6 twisted-pair copper cabling, which has been widely installed for 100BASE-T Ethernet networks. Organizations can easily implement Gigabit Ethernet by simply purchasing new hubs, switches, or routers and connecting the Power Mac G4. The Ethernet interface built into the Power Mac G4 operates at 10, 100, or 1000 Mbps, automatically sensing and adjusting to the user's network type.

AirPort Extreme

AirPort Extreme is an easy and affordable way to set up new networks and expand existing ones without installing new cabling or outlets. Antennas and a card slot for AirPort Extreme are built into the Power Mac G4, so you can surf the web without wires by installing an AirPort Extreme Card in your computer and connecting an AirPort Extreme Base Station to a phone jack or Ethernet network. AirPort Extreme, which is based on the IEEE 802.11g specification now nearing final approval, can transmit data about five times faster (54 Mbps vs. 11 Mbps) than the previous AirPort technology.[2]

With AirPort Extreme wireless networking, up to 50 AirPort-enabled computers can simultaneously connect to the Internet or join a wireless local area network through the base station. Those computers can include Apple iBook, eMac, iMac, PowerBook, and Power Mac G4 systems, as well as Wi-Fi certified 802.11b systems from other vendors. For more information about AirPort technology, visit www.apple.com/airport.

Bluetooth

Bluetooth is a short-range (up to 10 meters), low-power wireless technology that makes it possible to connect a multitude of devices to your Macintosh without requiring a cable. When Bluetooth is engaged, nearby devices are discovered automatically. Apple has fully integrated Bluetooth into Mac OS X v10.2 to ensure that users experience Bluetooth in a familiar, easy-to-learn, easy-to-use environment.

Bluetooth works across a multitude of different products, including mobile phones, handheld computers (such as Palm or Pocket PC), other Macintosh computers, and Windows computers. Apple's Bluetooth implementation is designed to connect to Bluetooth devices to get on the Internet, synchronize contacts or schedules, or transfer files easily. It is compliant with the most recent version of the Bluetooth specification (version 1.1), making it interoperable with other Bluetooth devices.

Modem

All new Power Mac G4 systems include a built-in 56K modem, and Mac OS X v10.2 supports V.92 modem functionality.[5] The V.92 standard provides the following features to enhance the Internet experience for users with dialup connections:

• Modem on Hold allows an Internet connection to be placed on hold to answer an incoming telephone call.

• PCM Upstream provides digital upstream transmission of data for faster uploading of files and email attachments.

• Quick Connect enables a faster hardware handshake with frequently used ISP numbers to shorten connect times.

Audio

The Power Mac G4 features dedicated stereo audio line in and line out ports for connecting professional devices such as tape decks and amplifiers. It's also equipped with an Apple speaker minijack for attaching Apple Pro Speakers and powering them with a built-in 10-watt-per-channel digital amplifier. A convenient headphone port is located on the front of the system, along with an internal mono speaker.

Audio output

Specifications	Line out connector	Headphone jack	Apple speaker minijack
Power		40 milliwatts (mW)	10 watts per channel
Full-scale amplitude	1.5V RMS for load greater than 1 KΩ		
Frequency response	8Hz to 20kHz (load independent)	40Hz to 20kHz	20Hz to 20kHz
Signal-to-noise ratio	Greater than 100 dB	Greater than 96 dB	Greater than 90 dB
Total harmonic distortion	Less than 0.004 percent		Less than 0.1 percent
Load		32 ohms	8 ohms

Audio input

Specifications	Line in connector
Data format	24-bit stereo, 44.1kHz audio sample rate
Maximum amplitude	2V RMS
Frequency response	5Hz to 20kHz
Signal-to-noise ratio	Greater than 100 dB
Total harmonic distortion	Less than 0.005 percent

Leading-Edge Graphics and Displays

The Macintosh is the premier platform for processing digital media of all types. The new Power Mac G4 features the latest in high-performance graphics solutions from NVIDIA and ATI, and a powerful AGP 4X graphics bus. For expansive viewing, Apple's all-digital flat-panel displays complete the picture. And support for dual displays—including two Apple flat panels—is built into every Power Mac G4.[7]

Choice of Graphics Cards

The new Power Mac G4 ships with a choice of AGP 4X graphics cards, each of which has at least 64MB of fast video memory. Off-the-shelf configurations feature an NVIDIA GeForce4 MX or ATI Radeon 9000 Pro graphics card. For the ultimate graphics experience, build-to-order systems can have an NVIDIA GeForce4 Titanium or ATI Radeon 9700 Pro (both featuring 128MB of DDR SDRAM) for incredible game play and stunning visualization. To provide full support for dual displays, all graphics cards feature both ADC and DVI connectors, and all Power Mac G4 systems come with a DVI to VGA adapter. (An optional Apple DVI to ADC Adapter is available if you want to connect two Apple displays with ADC to the computer.)

In addition to providing leading-edge 2D and 3D graphics performance, the NVIDIA GeForce4 Titanium, ATI Radeon 9000 Pro, and ATI Radeon 9700 Pro graphics processors are fully programmable. Graphics programmability allows software developers to create a vast array of custom special effects that will bring games and professional applications to life with sophisticated real-time visual effects and unsurpassed image quality.

NVIDIA GeForce4 MX
The GeForce4 MX incorporates NVIDIA's Lightspeed Memory Architecture II, making it capable of rendering more than 1.1 billion textured pixels per second. The GeForce4 MX features a large 64MB frame buffer with fast DDR SDRAM that supports large textures for realistic 3D graphics in today's games and professional visualization applications.

ATI Radeon 9000 Pro
The Radeon 9000 Pro is an advanced graphics card with a 64MB DDR SDRAM frame buffer. It features Smartshader technology, which allows users to experience complex, movie-quality effects for ultra-realism in next-generation 3D games and applications. In addition, ATI's Smoothvision technology enhances image quality by eliminating jagged edges and bringing out fine texture detail—without compromising performance. The Radeon 9000 Pro is ideal for high-performance gaming and design applications, and was the first card to bring graphics programmability into the Power Mac line as a standard feature.

NVIDIA GeForce4 Titanium

Based on NVIDIA's fourth-generation graphics processing unit, the GeForce4 Titanium delivers incredible visual effects and frame rates—for one of the most artistic, interactive, and immersive experiences available on any personal computer. With 128MB of fast DDR SDRAM and the Lightspeed Memory Architecture II, the GeForce4 Titanium can process more 3D data to the screen. This dramatically improves frame rates for games as well as manipulation of large 3D objects in professional applications.

In addition, the GeForce4 Titanium uses the nFiniteFX II engine for graphics programmability. Previously reserved for dedicated graphics workstations in commercial visualization environments, programmability allows developers of games and 3D graphics applications to achieve new levels of realism. With virtually limitless control over vertex and pixel shaders, developers can work with an infinite number of special effects possibilities.

ATI Radeon 9700 Pro

The Radeon 9700 Pro is an AGP 4X–compatible graphics card designed to outperform anything on the market today. Its revolutionary architecture is focused on performance, precision, and programmability.

This impressive graphics processor features a large 128MB frame buffer with superfast DDR SDRAM memory. Eight parallel rendering pipelines together with four parallel geometry engines can process more than 300 million transformed and lit polygons per second.

The Radeon 9700 Pro incorporates a new high-performance 256-bit DDR memory interface, providing nearly 20 GBps of graphics memory bandwidth. In addition, ATI's Hyper Z III technology reduces overdraw by detecting and discarding hidden pixels, reducing memory bandwidth consumption by more than 50 percent.

Like the other graphics options for the Power Mac G4, the Radeon 9700 Pro includes both ADC and DVI connectors to support multiple dual display configurations.

Standard configurations

	NVIDIA GeForce4 MX	ATI Radeon 9000 Pro
Memory architecture	Lightspeed Memory Architecture II	Quad pipe memory architecture
Effects engine	Hardware transform and lighting engine	Smartshader
Frame buffer memory	64MB	64MB
Triangles per second	34 million	43 million
Memory bandwidth	6.4 GBps	8.8 GBps

Build-to-order configurations

	NVIDIA GeForce4 Titanium	ATI Radeon 9700 Pro
Memory architecture	Lightspeed Memory Architecture II	Hyper Z III technology
Effects engine	nFiniteFX II	Smartshader 2.0
Frame buffer memory	128MB	128MB
Triangles per second	136 million	325 million
Memory throughput	10.4 GBps	19.8 GBps

Apple All-Digital Flat-Panel Displays

An Apple display is an essential component of the Power Mac G4 user experience. Apple offers a lineup of pure-digital flat-panel displays that provide superior image quality; vivid, accurate color; and the industry's best wide-viewing technology. The level of integration and the elegance of these displays present Power Mac G4 users with the best possible window on their work. At today's affordable prices, Apple flat-panel displays are the obvious choice for all levels of users.

All 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. They can be calibrated for color-managed workflow environments and will maintain consistent color and quality without requiring frequent recalibrations.

Apple currently offers three displays:

• The 17-inch Apple Studio Display, with its 1280-by-1024-pixel resolution, is an ideal alternative to a large CRT display. You get resolution comparable to that of a 21-inch CRT, but in a slim, lightweight design.

• The new 20-inch Apple Cinema Display makes high-resolution, widescreen viewing more affordable than ever. Leveraging the LCD technology used in the Apple Cinema HD Display, the Apple Cinema Display delivers superb color in resolutions up to 1680 by 1050 pixels and with a pixel density of 100 dots per inch. That's 1.7 million pixels you can put to work designing magazine layouts, editing film, or decoding a genetic sequence.

• The 23-inch Apple Cinema HD Display is a stunning LCD that offers 1920-by-1200-pixel resolution—enough to support high-definition video content with room to spare. Even with such a wide viewing space, text remains sharp and colors are vivid and distortion-free from edge to edge. The Apple Cinema HD Display is perfect for editing video or enhancing large graphics, permitting high-performance image manipulation in gorgeous, richly saturated, flicker-free colors.

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

Apple DVI to ADC Adapter

Dual Display Support

Dual display support is built into every Power Mac G4, making it easier and more cost-effective to add a second display.[7] Having two displays is useful for creative professionals, video editors, 3D designers, and scientific researchers who multitask between applications, often working with rich content and complex applications that include floating palettes and long timelines. All Power Mac G4 systems are capable of powering two Apple Cinema HD Displays for a staggering 3800-by-1200-pixel resolution—or more than 4.5 million pixels.

All new Power Mac G4 systems support both extended desktop and video mirroring modes. Extended desktop mode lets users distribute work across two displays. For example, Final Cut Pro users can view the detailed application interface on the primary display while displaying the final video output or other supporting applications on the secondary one. In contrast, video mirroring mode displays the same information on both displays. This enables a presenter to monitor and control a presentation on one display, while the audience watches it on a second display or projector.

All Power Mac G4 systems are equipped with an ADC port for connecting an Apple display and a DVI port for a second digital display. A DVI to VGA adapter is included for connecting to VGA displays. In addition, Apple offers the optional DVI to ADC Adapter so you can connect two Apple displays to your new Power Mac G4.

Power of Mac OS X

Mac OS X, Apple's most advanced operating system, helps you get the most from your Power Mac G4 system. It uses preemptive multitasking, symmetric multiprocessing, and multithreading capabilities to speed up individual applications and provide a true multitasking user environment. These features allow users of dual processor models to benefit even more, receiving the best performance that a Power Mac G4 and Mac OS X can deliver. Mac OS X is built on the Quartz graphics engine, which delivers significant quality and performance benefits, including faster and more responsive onscreen graphics with Quartz Extreme.

Preemptive Multitasking

Preemptive multitasking allows the operating system to dynamically adjust processing priorities between tasks and applications based on individual application needs and user requirements. This means users can run several processor-intensive applications all at the same time. For example, users can burn a DVD in the background while editing an image and checking email. Mac OS X is always monitoring user priorities and computer resources, and keeps the user interface fast and responsive.

In contrast, Mac OS 9 was designed for cooperative multitasking, which allowed processor-intensive applications to take control of the operating system, making the user interface unresponsive. This meant that users could virtually go out for a cup of coffee while their DVD project was encoded and burned to disc.

Symmetric Multiprocessing

Symmetric multiprocessing takes the preemptive multitasking concept to the next level by managing processing priorities between two processors. In symmetric multiprocessing, the operating system sees each processor as a resource that can be used for either operating system or application needs, and arranges tasks between processors for maximum efficiency.

For example, Mac OS X could encode video for a DVD on one processor, while an email application and an image editing application run primarily on the second processor. In this way, different tasks can be completed simultaneously on a dual processor system. In Mac OS X, any application can be assigned to any processor, and no special optimization is required for applications to take advantage of this feature. In Mac OS 9, applications had to be specially written to use a limited set of multiprocessor APIs to access the second processor in a dual processor system.

Multithreading

For maximum efficiency, processes can be broken down into subprocesses called threads, which can then be arranged between processors for even more performance. Many Mac applications have been rewritten to take advantage of the multithreading capability in Mac OS X, but even those that haven't can still benefit from this system-level feature.

For example, if you're creating a transition between two clips of video, the process includes decoding the first clip, decoding the second clip, rendering the transition, and re-encoding the transition into the original format. In Mac OS X, the two clips can be decoded at the same time, one on each processor. Afterwards, while the transition is rendering on one processor, finished frames can be re-encoded on the second processor. Because threads are processing in parallel, the process is completed in significantly less time.

Because Mac OS X is itself multithreaded, system as well as application processes can be divided between processors. For example, a networking thread could execute on one processor while a Finder thread executes on the other. The result is faster operating system performance and improved user interface response.

Advanced Graphics

Mac OS X is built on the Quartz graphics engine, which integrates with OpenGL technology for high-quality rendering of 2D and 3D graphics, and with QuickTime for displaying crisp video content. Quartz Extreme—first introduced in Mac OS X v10.2—leverages the power of the advanced graphics processor in the Power Mac G4 to make onscreen graphics faster and more responsive than ever before.

Quartz
Quartz is a powerful 2D graphics engine that delivers on-the-fly rendering, anti-aliasing, and compositing for pristine onscreen graphics. It features built-in support for the Portable Document Format (PDF), providing the power to embed and manipulate PDF data—and even save to PDF—with any application built for Mac OS X. Mac OS X v10.2 uses the full, open-standard PDF 1.3 imaging model to render high-quality, anti-aliased text, bitmap and vector graphics, and gradients and patterns onscreen and in print. It enables any Mac OS X application to save a color-managed PDF file. Quartz also supports ColorSync, Apple's color management technology, and provides native support for TrueType, Type 1, and OpenType fonts.

Quartz Extreme
Mac OS X is the only operating system with a composited windowing system—seamlessly blending 2D, 3D, and video content for vastly improved graphics performance. The window compositor taps the powerful graphics processing unit on each graphics card to efficiently render and composite graphics to the screen, resulting in high-frame-rate animation, transparency, and responsiveness. This work is handled by the graphics processor, freeing up the main processors for other tasks. With Quartz Extreme, the graphics processor essentially works as an extra processor on the Power Mac G4.

OpenGL

OpenGL is the industry's most widely used and supported 3D graphics technology. Its high-performance visualization capabilities make it ideal for gaming, 3D modeling, graphic design applications, and special effects. Mac OS X boosts the performance of OpenGL to a new level, making the Mac the ultimate personal computer platform for 3D graphics.

QuickTime 6

Mac OS X includes Apple's industry-standard QuickTime technology, the Internet standard for digital media and the engine that powers Apple's iMovie and Final Cut Pro applications. QuickTime Player provides sophisticated capabilities that let users play back full-screen video; watch live events over the Internet; view 360-degree Cubic VR; and open video, still images, and audio files in more than 30 standard formats, including the new MPEG-4 standard for streaming media.

Included Software

All Power Mac G4 systems come with a wide range of Apple and third-party software.

Apple Software

Developed specifically to run on Mac OS X, Apple's iLife digital media software—which includes iTunes, iPhoto, iMovie, and iDVD[8]—helps you reach your creative potential. You also get our new iCal calendar application and iSync for synchronizing calendar and contact information across multiple devices.

iTunes. You can easily convert audio CD files into MP3 files; create and organize your personal digital music library; download songs to an MP3 player to listen to on the go; or even burn your own custom music CDs with the SuperDrive or Combo drive.[9]

iPhoto. It's easy to save, organize, and share favorite images with iPhoto. It automatically imports photos from a USB-attached camera, catalogs them, stores them, and displays them on the computer screen.

iMovie. Apple's easy-to-use digital video editing software allows you to arrange and edit video clips, add transitions between scenes, create titles, and add credits. It offers a host of visual effects and powerful audio capabilities.

iDVD.[8] This software lets you create DVD-Video discs that can be played on almost any consumer DVD player. iDVD is simple enough to be used without any knowledge of DVD technology, yet powerful enough to create outstanding Hollywood-style DVDs.

iCal. This full-featured personal calendar application helps you manage your life and your time better than ever before. It provides a unique visual way to keep up with work schedules, family events, and appointments; and it's seamlessly integrated with the Mac OS X Address Book.

iSync. New cutting-edge synchronization software from Apple makes it easy to keep calendar and contact information harmonized between multiple Macintosh systems, or between a Mac and an iPod, Palm OS device, or Bluetooth-enabled mobile phone.

Also included with the Power Mac G4 are iChat, QuickTime, DVD Player, Mac OS X Mail, Mac OS X with the Classic environment, and Apple's Developer Tools—a complete, professional-quality developer environment for creating Mac OS X applications.

Apple software websites
Visit the following pages for additional information about the Apple products described in this section:
· www.apple.com/itunes
· www.apple.com/iphoto
· www.apple.com/imovie
· www.apple.com/idvd
· www.apple.com/ical
· www.apple.com/isync

Video professionals will also want to learn more about Final Cut Pro and DVD Studio Pro for video editing and DVD creation:
· www.apple.com/finalcutpro
· www.apple.com/dvdstudiopro

Third-Party Applications

The following third-party applications are included with the Power Mac G4:

QuickBooks for Mac New User Edition. This easy-to-use small business accounting software is from the makers of Quicken. It offers tools that help boost productivity and give you more control of your spending, your data, and your business forms.

Microsoft Office v. X Test Drive. This software lets you try out the world's most popular productivity suite.

Acrobat Reader. Adobe Acrobat Reader is the industry-standard software that lets you read and print any file in PDF format.

Art Directors Toolkit. This collection of functions streamlines working with color, fonts, and other aspects of graphic design.

EarthLink. This software helps you get connected to the Internet quickly and easily.

FAXstf. Flexible and easy to use, this program is for sending, receiving, and managing faxes.

FileMaker Pro Trial. This is an introduction to the leading database for workgroups and individuals in organizations of all sizes.

GraphicConverter. This software converts images to and from some 140 different formats.

Microsoft Internet Explorer. Microsoft's popular Internet browser lets you explore the web, find and manage information, and customize your workspace.

OmniGraffle. Generate charts, diagrams, graphs, and other statistical graphics.

OmniOutliner. By creating a flexible list or outline, this software helps you organize your ideas.

Real-World Results

The Power Mac G4 is widely recognized as the computer of choice for creative professionals, and offers benefits that are equally compelling for users in scientific, business, and education environments. It creates a fast, efficient digital workflow for accessing and manipulating data, visualizing the results, and outputting to various formats—no matter whether you're creating presentations, audio or video productions, magazines, web pages, or any other media.

However you use your Power Mac G4, the high performance will help you get your work done faster by rendering graphics, encoding audio and video, and crunching data at top speed. Dual processor configurations take that performance to even greater heights. Apple's advanced graphics technologies combined with the latest graphics cards provide the horsepower you need for demanding video editing, DVD creation, and scientific imaging operations. Support for two displays lets you keep tool palettes and work documents available at all times, whether you're designing a print layout, compositing video assets, or analyzing complicated data sets. And Gigabit Ethernet, USB, and FireWire enhance workflow by speeding file transfers and providing easy connectivity to peripheral devices like scanners and digital cameras.

The Power Mac G4 also gains a number of benefits from its operating system, Mac OS X v10.2 "Jaguar." Standards-based support for Windows, Linux, and UNIX network environments enables seamless integration into heterogeneous computing environments. And the true multitasking in Mac OS X maximizes user efficiency by letting you run several applications at once.

Thousands of applications are available for Mac OS X. They include leading special-purpose programs like Adobe Photoshop, BLAST, Final Cut Pro, Logic Audio, and Maya, as well as popular productivity software such as Microsoft Office.

Design and Publishing

The Power Mac G4 is central to the design and publishing process for magazines, websites, and other media projects around the world. From initial copywriting and page design to final production, it delivers results faster and more reliably than any other desktop computer.

In this line of work, deadlines are always on the horizon. A dual processor Power Mac G4 whips through image or video editing. Gigabit Ethernet and FireWire speed file transfers and communications with peripheral accessories, enabling designers to retrieve files from servers or download clips from video cameras quickly.

The built-in Mac OS X graphics technologies include broad font support. And because the Mac OS X Quartz composifier is based on PDF, any application can save a color-managed PDF file. With Apple flat-panel displays and the latest graphics cards, the Power Mac G4 handles high-quality color and image production and consistent color-managed workflows—both onscreen and in print. The SuperDrive (DVD-R/CD-RW) included in some configurations provides a convenient, inexpensive, and long-lasting solution for archiving and sharing large files on standard media.

AppleScript lets users automate routine tasks such as reformatting large groups of images for the web or building an entire online catalog with content stored on servers located across the globe. And the Common UNIX Printing System (CUPS) delivers industrial-strength configurability, compatibility, and reliability, enabling Mac OS X users to print to practically any printer, anywhere.

Photoshop performance

The superiority of the Power Mac G4 is evident when it's compared with Windows-based systems running Adobe Photoshop, the most common creative application used in publishing. Photoshop is an effective cross-platform measure of system per-formance because it is optimized for both the Macintosh and Windows platforms. It even takes advantage of the latest processor technologies on both platforms: SSE2 on the Pentium 4, and Velocity Engine and multiprocessing on the Macintosh.

The following Photoshop test comprises nine commonly used actions and filters that stress overall system performance, including the processor, memory, system bus, and hard drive. This test compares the new Power Mac G4 lineup to the fastest Pentium 4–based PC on the market.

Adobe Photoshop test

System	Percentage faster than Pentium system
Power Mac G4 Dual 1.42GHz	32%
Power Mac G4 Dual 1.25GHz	23%
Dell Dimension 8250 3GHz Pentium 4	Baseline

Longer bars indicate better performance. Test completed by Apple in January 2003.

The Power Mac G4 with dual 1.42GHz processors is 32 percent faster than a PC with a 3GHz Pentium 4 processor. The dual 1.25GHz configuration also outperforms a PC with a Pentium 4 processor running at more than twice the megahertz. This test demonstrates why megahertz alone is an incomplete measure of system performance.

3D Digital Content Creation

Creating models and animation for film and television special effects, games, websites, corporate videos, and scientific visualizations requires maximum processor performance and top-of-the-line graphics capabilities. The Power Mac G4 provides a robust platform that supports not only 3D design, but also full integration of 3D content into other media such as games and videos.

High-end graphics cards, OpenGL, and Quartz Extreme allow artists to interact with their data and models in real time. Gigabit Ethernet and FireWire 800 improve workflow by speeding up large file transfers. Artists working with large models and scenes can improve their productivity by spreading their work across two displays.

Leading 3D graphics software such as Maya is now available for Mac OS X, bringing the benefits of Apple's most sophisticated operating system to high-end animation and effects.

Film and Video

The Power Mac G4 has become the system of choice for film and video editing and compositing, serving as the foundation for high-end professional video solutions from Avid, Media 100, Pinnacle, and other companies. Apple-branded software solutions like Cinema Tools for Final Cut Pro, Shake, and DVD Studio Pro are available on Mac OS X to bring additional performance benefits to video professionals.

For real-time editing and effects, film and video editors will appreciate Quartz Extreme, which enables the layering of 2D, 3D, and video content into one composited desktop scene. The amazing performance of dual processor Power Mac G4 systems accelerates your editing and effects tasks. Finished projects can take advantage of the compact, durable, high-quality DVD format by using the SuperDrive (standard on some configurations; available as a build-to-order option on others).

Using 180GB hard disk drives, a Power Mac G4 can be outfitted with as much as 720GB of fast, internal capacity for storing hours of video content.[4] FireWire and USB provide connectivity to external storage solutions and other professional devices; and four open PCI slots enable the addition of specialized editing solutions, real-time processing cards, and I/O and SCSI devices. Video editors will also find it extremely useful to have a second Apple display—perfect for keeping video windows on one display, and timelines and palettes on the other.

Apple's new Final Cut Express software is a robust editing solution for digital video enthusiasts, small business video developers, and event videographers. Featuring the same interface as the Emmy award–winning Final Cut Pro, this feature-rich DV editing software is optimized for the DV format and comes with all the high-quality editing, compositing, titling, and effects capabilities for creating professional-quality videos.

Final Cut Pro 3 performance

The following test measures how well the Power Mac G4 performs with a high-bandwidth medium like video using Apple's Final Cut Pro 3. Final Cut Pro is an effective illustration of dual processor performance because it is multithreaded, allowing both processors to work simultaneously on the same application. The test protocol times common effects such as transitions, text over video, color balance, scaling, frame blending, and Gaussian blur.

Final Cut Pro test

System	Percentage faster than 500MHz Power Mac G4
Power Mac G4 Dual 1.42GHz	204%
Power Mac G4 Dual 1.25GHz	176%
Power Mac G4 1GHz	54%
Power Mac G4 Single 500MHz	Baseline

Longer bars indicate better performance. Test completed by Apple in January 2003.

Today's new dual 1.42GHz system outperforms the original 500MHz Power Mac G4, the system that introduced many professionals to video editing on the Mac, by 204 percent—or three times faster. The dual 1.25GHz system completed this test more than twice as fast, and the single-processor 1GHz Power Mac G4 system completed the test over 50 percent faster than the 500MHz Power Mac G4. Using any Power Mac G4 configuration, video editors will realize time savings that can be used to get more work done or to discover new creative solutions.

DVD authoring

DVD professionals need the computing power to combine video, images, and sound into a high-quality interactive multimedia experience, then produce high-quality final output for duplication or distribution.

The high-performance processors in the Power Mac G4 provide fast, high-quality MPEG-2 encoding for professional DVD results. Fast networking and I/O make importing and archiving assets fast and easy. State-of-the-art graphics and displays enable DVD professionals to view and manipulate content with high precision, comprehensive color management, and extensive font support.

When it's time to burn a video, the fast, versatile SuperDrive and an optional second optical drive streamline the authoring, archiving, and proofing of DVD productions. iDVD, included with every SuperDrive-equipped system, allows users who are new to the medium to get started, while the optional DVD Studio Pro software provides a full-fledged DVD production environment.

DVD encoding performance

The following test measures the effectiveness of the Power Mac G4 when encoding video, which is the most time-consuming part of burning a DVD. The test involves encoding a clip of video from digital video (DV) into MPEG-2 format. DV is the format used by standard DV cameras as well as by DVD Studio Pro and iDVD for creating and editing DVDs. MPEG-2 is the format used for high-quality television display by consumer DVD players. Both DVD Studio Pro and iDVD create final output in MPEG-2 format.

We compared both dual processor Power Mac G4 systems to one of the few PC-based DVD editing solutions on the market, the 3GHz Pentium 4–based Dell Dimension 8250 running Sonic DVDit Professional Edition with the Ligos encoder.

DVD video encoding test

System	Percentage faster than Pentium system
Power Mac G4 Dual 1.42GHz	32%
Power Mac G4 Dual 1.25GHz	12%
Dell Dimension 8250 3GHz Pentium 4	Baseline

Longer bars indicate better performance. Test completed by Apple in January 2003.

The dual 1.42GHz Power Mac G4 encodes video 32 percent faster than the 3GHz Dell solution. This illustrates that the unique system architecture of the Power Mac G4 delivers real-world performance gains that are unmatched by traditional Pentium 4–based PCs. The test also demonstrates the performance advantage of dual processors for computationally intense tasks such as video encoding.

Music and Audio

With the Power Mac G4, audio professionals can use MIDI and electronic music creation tools to compose and arrange music and audio for film, advertising, television, radio, and music recording.

Mac OS X brings high-definition 32-bit, 96kHz digital audio to every Power Mac G4 system. Its audio capabilities include digital signal processor (DSP) and virtual instrument plug-ins for the ultimate in audio processing.

As software becomes more advanced and digital rendering of sounds becomes more sophisticated, processing power gains paramount importance in audio projects. The dual processor Xserve-based architecture of the Power Mac G4 provides the power and bandwidth needed to support more simultaneous channels, plug-ins, and polyphony than ever before. FireWire and USB connect high-performance MIDI and multichannel audio devices, while high-quality stereo inputs and outputs provide connectivity for traditional analog devices. Four open PCI slots let you add specialized DSP cards or the latest I/O devices.

Emagic Logic Audio test

System	Tracks
Power Mac G4 Dual 1.42GHz	42 tracks/5 filters
Power Mac G4 Dual 1.25GHz	38 tracks/5 filters
Power Mac G4 1GHz	29 tracks/5 filters
Power Mac G4 Single 500MHz	18 tracks/5 filters

Longer bars indicate better performance. Uses Logic Audio to test maximum number of simultaneous audio tracks each with five commonly used filters. Test completed by Apple in January 2003.

This test compares the current line of Power Mac G4 systems against the original 500MHz Power Mac G4 using Logic Audio. It measures the maximum number of simultaneous audio tracks that can be played while applying five common filters to each track. The dual 1.42GHz system plays 42 simultaneous tracks, while the 500MHz Power Mac G4 system can play a maximum of 18 tracks. These performance enhancements can be attributed to overall system improvements such as faster processors, a faster system bus, Double Data Rate main memory, and higher-speed disk drives.

Science and Technical Computing

The typical researcher's desktop has two or more computers: a UNIX workstation for research applications, and a PC or Mac that runs mainstream applications for writing, visualization, and presentation. Thanks to Mac OS X, you can save money and space by using a single Power Mac G4 computer to run your vital UNIX and vector processing programs as well as productivity applications such as Microsoft Office. An optional second display lets you view multiple crucial applications simultaneously.

Of course, you'll be running all those programs on the powerful PowerPC G4 processor, which features the Velocity Engine for high-performance vector processing. That makes the Power Mac G4 ideal for users in the life sciences, physical sciences, and other technical computing disciplines, who require rapid computing and analysis of scientific data.

That speed, combined with industry-leading graphics, provides outstanding scientific visualization capabilities. Most Power Mac G4 configurations feature dual G4 processors for even higher performance.
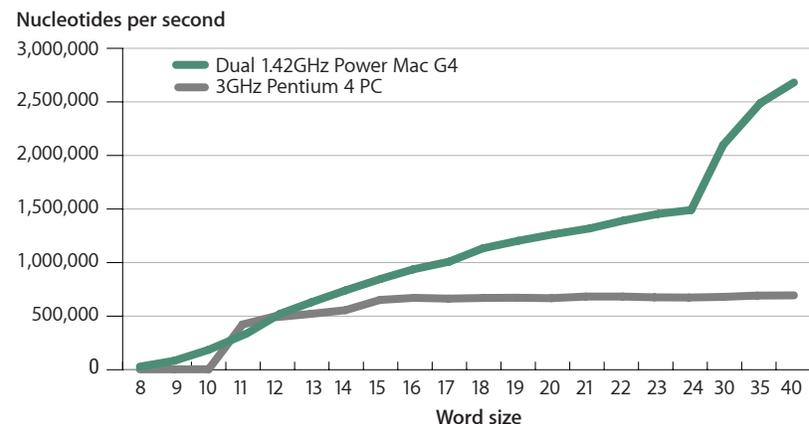
BLAST performance

To demonstrate the performance advantages of the Power Mac G4 for processor-intensive scientific analysis, we used BLAST (Basic Local Alignment Search Tool), the popular open source biotechnology application used by life science researchers to find similarities in DNA and protein sequences. As a research tool, BLAST is used for a broad variety of purposes, including the development of drug and gene therapies.

BLAST does its work by finding matches in DNA sequences and is typically very processor intensive. Searches in BLAST are based on word size, or the number of nucleotide pairs specified by the researcher to register as a match. For example, a word size of 40 means that two sets of genetic code have 40 nucleotides in common. Different word sizes are used for different kinds of research, and users can adjust word size to the sensitivity appropriate to their needs. Using dual processors, the Velocity Engine, and the UNIX-based power of Mac OS X, BLAST is accelerated to make a wide variety of searches available at higher speeds on the Power Mac G4. We compared the performance of the dual 1.42GHz Power Mac G4 running A/G BLAST to a Linux workstation with a 3GHz Pentium 4 processor running NCBI BLAST.

BLAST results

Nucleotides per second

Long word size (high performance). With long-word-size (high-performance) searches, the researcher is looking for similarities between DNA sequences that are nearly identical—for example, comparing DNA samples from two different mice. In common searches using a word size of more than 11, the dual 1.42GHz Power Mac G4 running A/G BLAST performs up to 3.8 times faster than a PC with a 3GHz Pentium 4 processor running Linux and NCBI BLAST.

Short word size (high sensitivity). For short-word-size searches (fewer than 11), the researcher is comparing more distantly related sequences, such as mouse versus human DNA. These searches require high resolution in order to find the small matches between these dissimilar sequences. Before A/G BLAST on the Power Mac G4, this kind of search was impractical using BLAST because of the enormous amount of time it required. The new Power Mac G4 makes these searches practical, with performance up to 38.5 times faster than the PC.

For more information on A/G BLAST, the PowerPC G4–optimized version of NCBI BLAST developed by Apple in collaboration with Genentech, and the Power Mac G4 in science and technology, visit www.apple.com/scitech.

Business and Productivity

If you're a small business owner, the Power Mac G4 gives you the power to run your business. Whether you have a hot ad shop or a biotech startup, the Power Mac G4 supports the applications you need for your core business front-office and vital back-office programs, for such tasks as accounting, database management, customer relationship management, marketing, backup, and support.

As your business grows, the Power Mac G4 can grow too. Not only can you enhance its hardware capabilities with more memory, storage capacity, and external devices, but you can also add Mac OS X Server software for comprehensive file sharing, email services, web hosting, and more.

Business professionals and anyone else who needs to deliver presentations will want to add Apple's new Keynote software to their Power Mac G4 systems. Keynote makes it a snap to create compelling presentations with professional-caliber themes, razor-sharp text, and beautiful charts and tables. It comes with 12 Apple-designed themes featuring coordinated backgrounds, fonts, colors, bullets, and tables and charts. You can customize any theme or create entirely new ones of your own. Keynote imports and exports PowerPoint, QuickTime, and PDF files to make creating and sharing pre-sentations easier than ever.
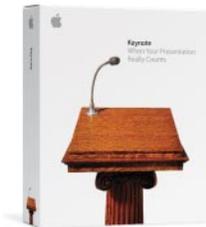
Education

Colleges and university departments of education, art and design, science and technology, and computer science recognize that Apple provides the cutting-edge solutions they need.

When students use creative tools like Photoshop in commercial art classes and Final Cut Pro in film classes, or research tools like BLAST in biology research, they experi-ence the ultimate in digital workflow technology.

Faculty will find in the Power Mac G4 a high-performance system that can run a wide range of curriculum-specific and general productivity software. Fast dual processing capabilities, state-of-the-art graphics and displays, dual display support, and massive expandability provide the best platform for creative and scientific applications. Because the Power Mac G4 can run both UNIX and Mac OS applications, it can take the place of the two workstations that many science and technology educators currently have. In addition, Mac OS X offers a robust UNIX development platform for computer science departments.

IT staff will appreciate the smooth way in which the Power Mac G4 integrates with existing peripherals and networks. Built-in FireWire and USB provide connectivity with high-performance devices, while the TCP/IP-based networking stack in Mac OS X works with Gigabit Ethernet for fast, standards-based network connectivity. Mac OS X v10.2 makes the Mac a first-class citizen in any Windows environment by providing Windows file sharing, secure remote access, and integration with Active Directory.

Other supported enterprise services include ODBC database access, SNMP remote administration, and CUPS printing. For easy authentication in heterogeneous environ-ments, Mac OS X v10.2 includes support for Kerberos, LDAP, Active Directory, and smart cards. Optional Mac OS X Server software provides powerful services for Internet and web serving, file and printer sharing, networking, and workgroup management.

Keynote, a new generation of presentation software, is ideal for creating professional-quality presentations. Designed for Mac OS X and featuring Apple's legendary ease of use, Keynote includes professionally designed themes, razor-sharp typography, and cinematic-quality transitions. Of particular interest to educators, Keynote makes it easy to create impressive charts and tables in seconds.

Product Details

Standard Configurations

Apple offers Power Mac G4 systems to meet the needs of creative professionals, educators, researchers, businesspeople, and home users. The following three standard configurations are available through the Apple Store and authorized Apple resellers.

Order number	M8839LL/A	M8840LL/A	M8841LL/A
Processor	1GHz PowerPC G4	Dual 1.25GHz PowerPC G4	Dual 1.42GHz PowerPC G4
L3 cache	1MB DDR SRAM	1MB DDR SRAM per processor	2MB DDR SRAM per processor
System bus	133MHz	167MHz	167MHz
Main memory (2GB maximum[6])	256MB PC2100 (266MHz) DDR SDRAM	256MB PC2700 (333MHz) DDR SDRAM	512MB PC2700 (333MHz) DDR SDRAM
Hard drive	60GB Ultra ATA/100; 7200 rpm[4]	80GB Ultra ATA/100; 7200 rpm[4]	120GB Ultra ATA/100; 7200 rpm[4]
Optical drive	Combo (DVD-ROM/CD-RW)	Combo (DVD-ROM/CD-RW)	SuperDrive (DVD-R/CD-RW)
Graphics support	NVIDIA GeForce4 MX with 64MB of DDR SDRAM	ATI Radeon 9000 Pro with 64MB of DDR SDRAM	ATI Radeon 9000 Pro with 64MB of DDR SDRAM
Expansion slots and bays	Four open full-length 64-bit, 33MHz PCI slots; AGP 4X slot with graphics card installed; four DIMM slots; four internal hard drive bays (one occupied); two optical drive bays (one occupied)		
Ports	One FireWire 800 port, two FireWire 400 ports, four USB ports, front headphone minijack and speaker, rear Apple speaker minijack, audio line in and line out minijacks, ADC and DVI connectors for dual display support		
Networking	Built-in 10/100/1000BASE-T Ethernet and 56K V.92 modem[5]; AirPort Extreme ready[2]; Bluetooth ready		
Software	Mac OS X with Classic environment, QuickTime, iCal, iChat, iLife (includes iTunes, iPhoto, iMovie, and iDVD[8]), DVD Player, iSync, Mac OS X Mail, Microsoft Internet Explorer, EarthLink (includes 30 days of free service), Acrobat Reader, Art Directors Toolkit, FAXstf, FileMaker Pro Trial, GraphicConverter, Microsoft Office v. X Test Drive, OmniGraffle, OmniOutliner, QuickBooks for Mac New User Edition, and Apple's Developer Tools		
Service and support	90 days of free telephone support and one-year limited warranty		
Also included	Apple Pro Keyboard, Apple Pro Mouse, USB keyboard extension cable, DVI to VGA adapter, modem cable		

Build-to-Order Options

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

- Memory (PC2100 or PC2700 DDR SDRAM): 256MB, 512MB, 1GB, 1.5GB, 2GB

- Hard drives: 60GB Ultra ATA/100 (7200 rpm), 80GB Ultra ATA/100 (7200 rpm), 120GB Ultra ATA/100 (7200 rpm), 180GB Ultra ATA/100 (7200 rpm)

- Optical drives: SuperDrive (DVD-R/CD-RW), Combo drive (DVD-ROM/CD-RW)

- Graphics: NVIDIA GeForce4 MX with 64MB DDR SDRAM, ATI Radeon 9000 Pro with 64MB DDR SDRAM, NVIDIA GeForce4 Titanium with 128MB DDR SDRAM, ATI Radeon 9700 Pro with 128MB DDR SDRAM

- Audio: Apple Pro Speakers, Apple iPod, Harman Kardon iSub and SoundSticks

- Wireless: AirPort Extreme Card, AirPort Extreme Base Station, built-in Bluetooth module (The Bluetooth module is not user installable; it must be requested when you order your Mac system. If you decide after purchase that you want Bluetooth capability, you will need to buy an external Bluetooth adapter.)

- Other: Mac OS X Server, Ultra SCSI PCI Card, and DVD-R Media Kit

Apple Displays

To complete your Power Mac G4 system, you can choose from Apple's family of all-digital 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, order number M8661LL/A (for connecting a second Apple display)

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 the Power Mac and display are purchased together. For more information, visit www.apple.com/support/products or call 800-823-2775.

Technical Specifications

Processing and memory
- 1GHz, dual 1.25GHz, or dual 1.42GHz PowerPC G4 processors
- Velocity Engine vector processing unit
- Full 128-bit internal memory data paths
- Powerful floating-point unit supporting single-cycle, double-precision calculations
- Data stream prefetching operations supporting four simultaneous 32-bit data streams
- 256K on-chip L2 cache running at processor speed
- Up to 2MB DDR SRAM L3 cache per processor with up to 4-GBps throughput
- Up to 167MHz system bus supporting over 1.3-GBps data throughput
- 256MB or 512MB of PC2100 (266MHz) or PC2700 (333MHz) DDR SDRAM main memory supporting up to 2.7-GBps throughput
- Four DIMM slots supporting up to 2GB of DDR SDRAM using one of the following[6]:
  – 256MB DIMMs (64-bit-wide, 128- or 256-Mbit)
  – 512MB DIMMs (64-bit-wide, 256-Mbit)

Graphics and display support
- One of the following graphics cards installed in a dedicated AGP 4X graphics slot:
  – NVIDIA GeForce4 MX with 64MB of DDR SDRAM
  – ATI Radeon 9000 Pro with 64MB of DDR SDRAM
  – NVIDIA GeForce4 Titanium with 128MB of DDR SDRAM (build-to-order option)
  – ATI Radeon 9700 Pro with 128MB of DDR SDRAM (build-to-order option)
- Support for digital resolutions up to 1920 by 1200 pixels, and 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 displays[7]

Storage and expansion
- Four 3.5-inch hard drive expansion bays
  – One 60GB, 80GB, or 120GB 7200-rpm Ultra ATA/100 drive preinstalled in standard configurations (180GB build-to-order-option)[4]
  – Support for up to four internal ATA drives (two Ultra ATA/100 and two Ultra ATA/66)
  – Support for up to four internal SCSI drives (requires third-party solution not offered by Apple)
  – Support for a combination of internal ATA and SCSI drives (maximum total of four)

- One of the following optical drives:
  - SuperDrive (DVD-R/CD-RW); writes DVD-R discs at 4x speed, reads DVDs at 8x speed, writes CD-R discs at 16x speed, writes CD-RW discs at 8x speed, reads CDs at 32x speed
  - Combo drive (DVD-ROM/CD-RW); reads DVDs at 12x speed, writes CD-R discs at 32x speed, writes CD-RW discs at 10x speed, reads CDs at 32x speed
  - Optional Combo drive in second optical drive bay
- Four open full-length 64-bit, 33MHz PCI slots
- One AGP 4X slot with graphics card installed

Communications
- 10/100/1000BASE-T Ethernet connector (RJ-45)
- Built-in antennas and expansion slot for optional 54-Mbps AirPort Extreme Card (based on IEEE 802.11g draft specification; 802.11b Wi-Fi certified)[2]
- Built-in 56K V.92 modem[5]
- Optional Bluetooth 1.1 module

Peripherals and audio
- One FireWire 800 port and two FireWire 400 ports (15W total power)
- Four USB ports (two on system, two on keyboard)
- Front headphone jack and speaker
- Stereo audio line in and line out minijacks
- Apple speaker minijack for connection to optional Apple Pro Speakers

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: 7A (low-voltage range) or 3.5A (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: 17.0 inches (43.2 cm)
- Width: 8.9 inches (22.7 cm)
- Depth: 18.4 inches (46.8 cm)
- Weight: 42 pounds (19.1 kg)[10]

For More Information

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