Apple Cinema Displays

Technology Overview
May 2005

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Introduction

Whether you are generating ad layouts, editing film, or decoding a genetic sequence, Apple provides the definitive system to maximize your creativity and efficiency. Thanks to Apple's powerful dual processor Power Mac G5 line and Mac OS X, the world's most advanced operating system, you can run more applications simultaneously with exceptional reliability and speed. Apple's elegant flat-panel displays complete the fluid, integrated experience.

Building on our commitment to maximizing your productivity, Apple now provides a stunning new window into your work: the 30-inch Apple Cinema HD Display. With a larger workspace than any other Apple display, it represents the latest in a series of breakthroughs from Apple aimed at providing you with the ideal creative system.

While other displays are designed to help suppliers maximize manufacturing efficiencies, the Apple Cinema Display line is designed from the ground up with the professional Macintosh user in mind. Apple carefully considers the requirements of creative professionals who need to see two-page layouts at full size with room for palettes and menus, HD video content at full resolution, or complex genetic sequences.

Apple pioneered the move to LCD technology in 2001 with an award-winning line of all-digital active-matrix flat-panel displays, and has been building the industry's most innovative, elegant displays ever since. Based on advanced LCD technology, the Apple Cinema Display line delivers performance that is superior to that of any CRT-based display. When compared with other LCD options, the Apple line stands out due to its wide-aspect design, DVI connector, integrated FireWire and USB ports, and the amazing attention to detail of the ultrathin bezel, brushed aluminum enclosure, and adjustable stand.

There are three models in Apple's flat-panel display line. The 20-inch Apple Cinema Display features Apple's innovative widescreen format, offering a large workspace for creative, home, and business users. The 23-inch Apple Cinema HD Display is ideal for customers working with multipage layouts and video, while the breakthrough 30-inch Apple Cinema HD Display meets the needs of the most demanding professional users, offering more screen real estate than virtually any other desktop monitor on the market.

If you're purchasing a new Power Mac G5 computer, an Apple flat-panel display completes your system. If you already have a Power Mac and a CRT, consider upgrading to one of these superior-quality, space-saving displays. Or if you already use a flat-panel display, add a second one to your Power Mac for the ultimate in productivity. And if you have a PowerBook G4, an Apple display can extend your workspace even further.*

Product Overview

Benefits of Apple Cinema Displays

Apple Cinema Displays offer the following advantages:

- Large color gamut for use in color-critical applications
- Industry-best viewing angle of up to 170° horizontally and vertically for minimal color shift
- Pixel density optimized for display of both text and graphics
- Fast pixel response for crisp, full-motion digital video playback
- Stunning new industrial design that coordinates with the aluminum enclosure of the Power Mac G5 and PowerBook G4 computers
- Ultrathin bezel that minimizes visual distraction for applications requiring dual monitors for maximum screen real estate
- Industry-standard Digital Visual Interface (DVI) for direct connection to Power Mac computers, PowerBook G4 computers, and PCs*
- Two built-in FireWire 400 ports for easy connection of an iSight camera and other desktop devices
- Two-port, self-powered USB 2.0 hub for connection of high-bandwidth peripherals
- Unique hinge design for effortless adjustment
- Optional VESA mount adapter kit for mounting displays in locations other than the desktop
- Kensington security port to secure the display when using the included stand or an alternate mounting solution

The Apple Cinema Display Line

Apple offers three widescreen displays to choose from:

- The largest LCD ever designed for the personal computer, the 30-inch Apple Cinema HD Display (2560-by-1600-pixel resolution) puts more than 4 million pixels at your fingertips for maximum productivity.
- The 23-inch Apple Cinema HD Display (1920-by-1200-pixel resolution) supports high-definition content for showing more of your work in stunning color.
- The 20-inch Apple Cinema Display (1680-by-1050-pixel resolution) shows more than two full pages of graphics, layouts, and text, or DVD movies in wide format.

Choosing an Apple Display

Which Apple display is right for you? Although individual needs can vary widely, here are some typical ways in which people use the different models.

The 20-inch Apple Cinema Display

The 20-inch Apple Cinema Display makes high-resolution, widescreen viewing more affordable than ever. This is a truly professional display for Power Mac, PowerBook, and PC users that measures up to the most color-critical work. With its 1680-by-1050-pixel resolution, this flat-panel LCD is an ideal alternative to a bulky CRT monitor. In fact, despite having only a fraction of the size, weight, and power consumption of a comparable 21-inch CRT, this display provides the same amount of workspace.

- The 20-inch Apple Cinema Display is ideal for page layout. You can view a two-page spread and keep tools and palettes handy at all times in applications such as Adobe InDesign and QuarkXPress. The display's digital design means that the colors you see onscreen are the colors you'll get on paper.
- With Apple Final Cut Express software, you can deliver a professional-quality business video or edit footage from a family event. The wide-format design of the Apple Cinema Display allows you to see both your source and destination video windows simultaneously, as well as more of your timeline than on a standard non-wide-format screen.
- Small business users will appreciate being able to view more of a spreadsheet, finance report, or database record in applications like Microsoft Office and Intuit QuickBooks.
- Gamers will love the bright colors and detailed game environments possible with the Apple Cinema Display. The graphics cards available in Power Mac G5 computers allow games to be played at high resolutions with virtually no degradation in frame rates.
- This display is ideal for home users surfing the web with Apple's Safari browser. With desktop workspace equivalent to that of a 21-inch CRT, you can have multiple browser windows open simultaneously. You can keep up on the latest news or shop online—without having to constantly toggle between windows.
- Give your PowerBook a larger desktop canvas. Connect the 20-inch Apple Cinema Display directly to any PowerBook G4 with a DVI port.

The 23-inch Apple Cinema HD Display

The 23-inch Apple Cinema HD Display has enough resolution to support high-definition video content with room to spare, and it is ideal for color-critical work. This display delivers superb color in resolutions of up to 1920 by 1200 pixels. You can put it to work designing magazine layouts, editing film, or analyzing the latest protein molecule.

- Video editors using Apple's Final Cut Pro software can view multiple video and timeline windows on the 23-inch Apple Cinema HD Display. Its wide-format screen can display an entire high-definition video frame with ease or show multiple standard-definition videos at full size simultaneously. Using the Digital Cinema Desktop feature of Final Cut Pro HD and Final Cut Pro 5, you can play back full-screen HD video on the Apple Cinema HD Display, giving you superb image quality for a fraction of the cost of typical HD monitors. Add an interface from eCinema Systems, and you can even use the 23-inch Apple Cinema HD Display to view high-definition serial digital interface (HD SDI) signals used in broadcast television environments at their true intended resolution.
- Scientific research demands high resolution and responsiveness from a computer display, both of which are specialties of the 23-inch Apple Cinema HD Display.
- The 23-inch Apple Cinema HD Display makes laying out multiple-page spreads a pleasure, with easy access to all the tools and palettes you need in applications such as Adobe Creative Suite. Designed with a pure digital interface to deliver distortion-free images and enable precision editing, this display excels at handling even the most color-critical work.
- Bring your PowerBook G4 home to a big, bright Apple Cinema Display for the ultimate combination of portability and presence. Connect the 23-inch Apple Cinema HD Display directly to any PowerBook G4 with a DVI port.

The 30-inch Apple Cinema HD Display

The 30-inch Apple Cinema HD Display delivers an amazing 2560-by-1600-pixel resolution—it's the largest LCD ever created for a personal computer. Designed specifically for the creative professional, this display provides more space for easier access to all the tools and palettes needed to edit, format, and composite your work. Combine it with the stability and advanced capabilities of Mac OS X, and you can be more productive in more applications, from page layout to video editing and DVD authoring.

With a viewing space that can only be described as vast—the 30-inch display offers a 77 percent increase in screen real estate even when compared with the 23-inch Apple Cinema HD Display—text remains sharp and colors are vivid.

- Graphics and publishing professionals won't find a display better suited to their needs. It provides ample room to view more of your work than you ever thought possible. It's perfect for manipulating large graphics, permitting high-performance image editing in gorgeous, richly saturated colors.
- Combine the 30-inch Apple Cinema HD Display with Apple's Final Cut Pro, Motion, and Shake software, and you have a video and visual effects powerhouse. Its wide-format screen can display an entire high-definition video frame with ease or show multiple standard-definition videos at full size simultaneously. It also works with the eCinema Systems interface, allowing you to view HD SDI signals.
- Scientific and technical users will appreciate being able to visualize more of their work, whether they are simulating protein folding or analyzing detailed imagery obtained from a scanning electron microscope.
- Use the impressive 30-inch Apple Cinema HD Display right out of the box with the dual processor 2.7GHz Power Mac G5 and its ATI Radeon 9650 graphics card. Or add the NVIDIA GeForce 6800 Ultra DDL graphics card to any Power Mac G5 system to use up to two 30-inch displays. These graphics cards, designed specifically to support the dual-link DVI connection, deliver 2560-by-1600-pixel resolution.
- Every PowerBook G4 computer offers DVI output, providing the highest video output quality with a pure digital connection from the graphics processor to your DVI equipped display or projector. Standard on the 17-inch PowerBook and optional on the 15-inch model, 128MB of graphics memory with dual-link DVI functionality supports the 30-inch Apple Cinema HD Display.

LCD Benefits

Cathode-ray tube (CRT) monitors are quickly being surpassed in popularity by liquid crystal displays (LCDs). In 2003, unit volume shipments of LCD-based displays in the personal computer market exceeded those of the CRT. In fact, it is believed by a leading display research company that by the end of the decade it will be difficult to find a CRT to purchase for your personal computer. It is no longer a question of whether LCDs will be accepted as a viable display alternative, but rather how long it will take for LCDs to be the only alternative.

Apple pioneered the move to LCD technology in 2001 with an award-winning line of all-digital active-matrix flat-panel displays, which provide the following advantages over CRTs:

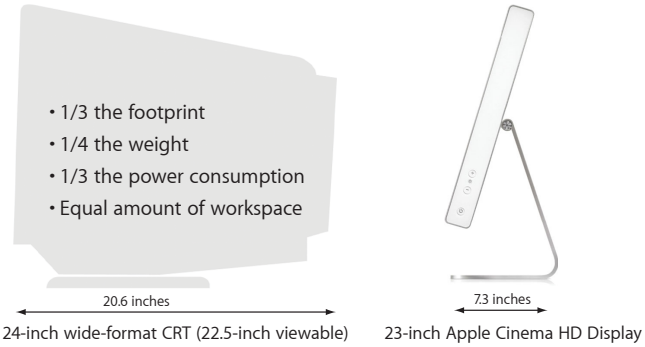
- A thin, light form factor
- Excellent visual quality
- Best technology for wide-format designs
- Low power consumption

This section focuses on the benefits offered by today's best active-matrix thin film transistor (TFT) flat-panel displays, such as those offered by Apple.

Thin, Light Form Factor

The first thing you notice about any LCD display is its slim and light design. Using two thin sheets of glass to enclose the liquid crystal material allows a flat-panel display to have a dramatically smaller desktop "footprint" when compared with a conventional monitor and its bulky cathode-ray tube. In fact, a flat-panel display averages about one-third the desktop space and weight of a comparable CRT.

With their smaller footprint, LCD displays allow more desktop computers to be set up in places where they may not have previously fit, such as crowded audio and video studios as well as home, office, and school environments. A breakthrough feature of the Apple display line is an optional VESA mount that makes it possible to configure the displays in any number of imaginative ways, from making them a seamless part of museum kiosks to mounting them on hotel lobby walls.



The 23-inch Apple Cinema HD Display has one-third the footprint, is nearly one-fourth the weight, and consumes just one-third the power of a bulky 24-inch CRT display.

Excellent Visual Quality

Today's best LCDs deliver about twice the brightness, sharpness, and contrast of a CRT display. They are also flicker-free and resistant to many of the environmental factors that affect the visual performance of CRTs.

Brightness and contrast
Active-matrix LCD displays are twice as bright as comparable CRT displays. When designing CRT displays, engineers must always make a tradeoff between brightness and sharpness. If the CRT screen is made brighter, the text typically becomes less sharp. That's because CRT technology is based on phosphors emitting light after they've been excited by an electron beam. The more energy in the electron beam, the more the phosphors will glow. Unfortunately, as a given phosphor glows brighter, it becomes harder to distinguish it from neighboring phosphors. The result is that adjacent pixels become less distinct and therefore less sharp.

Flat-panel displays don't suffer from this limitation. They simply turn each pixel on and off using transistors directly in the screen that activate the liquid crystal layer with electricity. This means an LCD can be made very bright without reducing the clarity of text or graphics. A key benefit of a bright screen is that it allows you to view fine details and subtle color differences even in well-lit standard office and home environments.

Another benefit of increased brightness is better contrast ratio. Contrast ratio is defined as the ratio between the whitest white and the blackest black on a display—its dynamic range, if you will. Because flat-panel displays are brighter, they can create brighter whites, thus instantly increasing the contrast ratio. On the other hand, the glass surface of a CRT screen tends to scatter the ambient light of well-lit environments, further reducing the contrast ratio and washing out colors. An LCD does not exhibit this effect, so it displays blacker blacks in standard office illumination settings. You can see the difference by comparing an LCD and a CRT side by side when they're turned off.

Sharpness

In a CRT, the energy from the electron beam hitting the phosphors creates light, which fades after the beam sweeps to other parts of the screen. The sharpness of a CRT is determined by the size of the area excited by the electron beam. To minimize the apparent flicker of the phosphor being excited and fading, a good CRT monitor updates each part of the screen at an extremely fast rate—75 times a second or more. However, at those speeds it's difficult to control the spot size of the electron beam and therefore to create a sharp transition between black and white areas. So a high refresh rate and a sharp image are difficult to implement simultaneously at high resolutions.

A digital active-matrix display isn't subject to the physical limitations of an electron beam being swept across the screen. Each pixel is physically separated from the others and has an electronic switch that is turned on or off independently. A black pixel can be adjacent to a white pixel with no difficulty. The result is an incredibly sharp display.

Lack of flicker

It is widely accepted that watching a flickering monitor for an extended period can cause eyestrain and associated headaches. Modern CRT displays with high refresh rates have minimized flickering in their images. LCDs, however, offer an inherent advantage in this regard: They have no electron beam rapidly "painting" an image on the screen line by line. Each and every pixel on an LCD is simply turned on and off independently whenever needed.

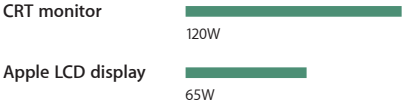
Ideal for Wide-Format Designs

Another advantage of LCD displays is based on simple geometry. In a CRT monitor, the electron beam emanates from the center of the cathode-ray tube, so at the edges of the screen, it hits the phosphors at a noticeable angle, rather than straight on. The beam's footprint becomes oval rather than circular, causing inevitable clarity problems at the edges of the CRT screen. This problem is even more dramatic in wide-format CRTs, because the electron beam must be deflected at an even greater angle to reach the edges and corners.

LCDs, by comparison, have no beam hitting the screen edges at an angle, and therefore no geometry problems. The pixels at the edge of an LCD are as crisp as the ones in the center. Because of this, LCD displays are better devices for wide-aspect-ratio designs. Creative content—two-page spreads, multiple web pages, video timelines, and cinematic content—is often wider than it is tall, making an LCD better suited to support many creative applications.

Low Power Consumption

Low power consumption
Good for the environment, good for the bottom line.



Reducing power usage mitigates energy waste, thereby helping to reduce the environmental impacts associated with gaseous emissions of power generation plants. Low power consumption also means increased savings over the life of the display.

Although visual quality plays an important role in selecting a monitor, cost of ownership and the display's impact on the environment are also significant factors. Apple recognizes that reducing environmental impact starts with the design of our products. Therefore, we set high standards—based on our own requirements and those set out by recognized programs such as ENERGY STAR—in an effort to create products that offer excellent environmental performance throughout their life cycle.

Apple's displays are no exception. With the pioneering move to all-digital LCD technology in 2001, Apple offered the market a full line of award-winning displays that consume one-third the power that CRTs use. CRT monitors need a lot of electricity to power the magnetic system used to deflect the electron beam across the entire screen and back 75 times or more per second. Instead of this electron beam, LCDs use a backlight and thin film transistors (TFTs) at each pixel location to drive the display mechanism. The backlight and transistors use only a fraction of the electricity needed to power a CRT. The net result of using a TFT active-matrix LCD versus a CRT-based display is a dramatic savings in energy costs over time. That's good for the environment—and for your budget.

Apple LCD Benefits

From their precision color technology to their head-turning design, Apple Cinema Displays deliver sharp text and stunning colors. Not only do Apple displays offer advantages over CRT displays, but they also offer advantages over competitors' LCD displays.

The display is an integral part of your computing experience. That's why Apple pays as much attention to creating quality displays as to creating powerful computers and innovative software. Whether you choose the 20-inch Apple Cinema Display, the 23-inch Apple Cinema HD Display, or the 30-inch Apple Cinema HD Display, you'll enjoy a wide viewing angle, fast responsiveness, a pure digital connection, and seamless integration with the other components of your Mac system.

Optimized for Graphics and Text: A Balanced Design

Apple strives for the ideal combination of size, resolution, and format in the design of each of its displays. Other display manufacturers start their designs with a monitor size that optimizes manufacturing efficiency. Apple works closely with suppliers to specify wide-format designs that meet the requirements of creative professionals—who need to see two-page layouts at full size with room for palettes and menus, HD video content at full resolution, or complex genetic sequences.

Apple has determined that the ideal balance between monitor size and number of pixels is approximately 100 pixels per inch (ppi). At 100 ppi, the display is optimized for images, yet it allows you to work easily with applications that require manipulation of text, such as sophisticated type treatments in layouts.

Wide-Viewing-Angle Technology

What distinguishes Apple displays from many other LCDs is the technology used to extend the viewing angle. Without it, colors viewed off-axis can shift in color, contrast, gamma or all three attributes. Off-axis color consistency is especially important in displays that have a wide aspect ratio, as pioneered in the Apple Cinema Display line. An inferior wide-viewing-angle technology could cause significant perceived variations between a color in the middle of the screen and the same color in the corner of a wide-format display.

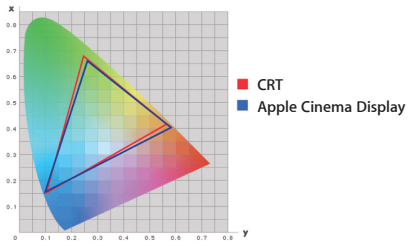
The technology used in Apple displays is the best in the industry at minimizing color shift at wide angles. LCDs that use other viewing-angle technologies can't measure up to the off-axis color performance of an Apple display.

Color Quality

For many Mac users, color quality is a critical factor in their work. Traditionally, CRTs have been an important link in the color proofing system for content ultimately destined for print, web, or video distribution. Flat-panel displays must provide equal or better results in these color-critical applications if media professionals are to accept them. Since Apple introduced the first LCD displays in 2001, they have performed superbly in color-critical environments.

Many factors define a color-accurate monitor. For example, a monitor must be able to display a broad color gamut that is consistent from edge to edge and over time—no matter where it's located. In short, it must provide accurate, predictable, and consistent colors.

1931 CIE chromaticity diagram
The broad color gamut of the Apple Cinema Display is virtually the same as that of professional-quality CRT displays.

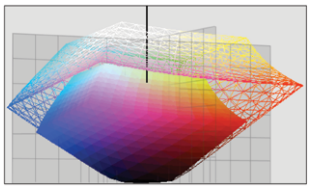


Color gamut

A group of scientists and intellectuals who called themselves the Commission Internationale de l'Eclairage (CIE) had the goal of defining color. Using as much objectivity as is possible with this highly subjective topic, they developed a coordinate system for categorizing the world of colors. Theoretically, based on this system, every color we see can be described in terms of x, y coordinates for red, green, and blue components. Taking it one step further, every device that reproduces colors can also be described based on the x and y values of its red, green, and blue colors. The total number of colors prescribed by the two-dimensional plot of these x and y coordinates is often referred to as the device's "color gamut."

The first question in a comparison of LCD versus CRT color quality is whether the color gamut of today's best LCDs is as extensive as that of the CRT. The answer is yes. Plotting the x, y values for the red, green, and blue colors shows that the color gamut of an LCD is as large as that of a typical CRT. In other words, there are no longer any compromises in the total colors available when using a flat-panel display.

Comparison of a typical 21-inch CRT and the Apple Cinema Display
The increased brightness of the Apple Cinema Display produces a much larger perceptual color gamut.



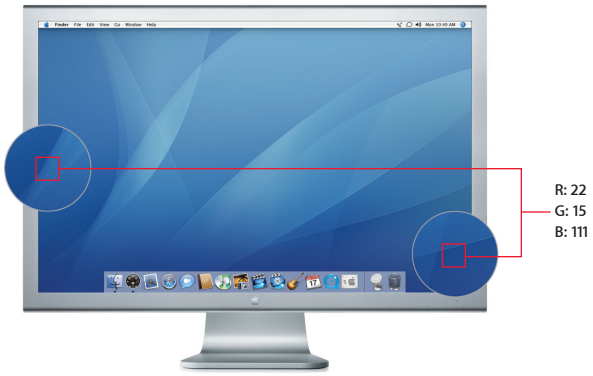
In addition to this two-dimensional color description, color has a third dimension: its brightness. As previously described, a flat panel substantially outperforms a CRT on the brightness axis. Adding this third dimension to the color comparison shows that the total volume of colors perceived from an LCD such as the Apple Cinema Display actually becomes larger than the volume of colors corresponding to a CRT.

While it's difficult to notice the impact of brightness on color when you view CRTs and LCDs independently, it's easy to see the difference when you put the two types of monitors side by side. You'll immediately notice that the LCD's colors appear more vivid and lifelike because its total color gamut is perceptually larger than that of the CRT. The benefit of this larger perceptual gamut is that you can use the LCD in normally lit settings such as offices and homes—with little reduction in the dynamic range of colors being displayed (that is, without the colors becoming washed out). A CRT in a darkened room performs similarly to an LCD in this regard, but the LCD provides a greater color range in a room that isn't dark. Content creators who have been forced to sit in darkened rooms to do their work on a CRT will appreciate this difference.

Uniform color

We described how important it is for a display to be capable of reproducing a large number of colors; that is, providing a large color gamut. Equally important is that it be able to display that broad color gamut over the entire screen, over a wide range of physical locations, and over time. Each of these concerns is an aspect of color uniformity—a goal that display manufacturers are constantly striving to achieve.

Apple's display family offers excellent color uniformity over the entire screen, both from top to bottom and from side to side. An important reason why color uniformity is possible with recent LCD designs is the development of wide-viewing-angle technologies. Users viewing the 30-inch Apple Cinema HD Display from a typical distance of 20 inches will be seeing the color in the corners of the display at an angle. Without wide-viewing-angle technology, the colors at those extreme locations would shift.



Apple LCD displays deliver uniform color values across the entire screen.

Why LCDs are more stable

Viewing conditions can also vary widely around the globe. Terrestrial magnetism, heat, humidity, altitude, and local electromagnetic fields all play a role in causing an analog CRT display to become misaligned—leading to image degradation and color distortion. LCDs are immune from the negative impact of such worst-case viewing environments. Here are several real-world situations in which a CRT display could be adversely affected by environmental factors:

- Position your CRT in a north/south orientation. It will behave differently than when it's in an east/west orientation.
- Position your CRT near a pair of unshielded stereo speakers or in an office building next to an elevator shaft. You may see a dramatic change in screen colors because of magnetic field interference with the electron beam being fired at the phosphors.
- Tap the side of a CRT that uses an aperture grille mask and notice how the vibration of the grille distorts the image.
- Have a user in the Northern Hemisphere send an important color file to a client site in the Southern Hemisphere, or vice versa. The different terrestrial magnetism of the two hemispheres creates different effects on CRTs in the two locations.

In all of these real-world scenarios, Apple LCDs provide much more accurate and predictable colors than CRTs.

Graceful aging

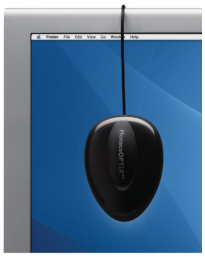
Another aspect of color uniformity is how predictable it is over time. With extended use, every monitor will change. The goal for display manufacturers is to minimize the impact of these changes on the display's color performance. In this regard, the LCD again has an advantage over CRTs.

CRT displays work by having an electron beam excite inorganic phosphors, which in turn emit a red, green, or blue color. As the CRT ages, the ability of these phosphors to uniformly emit color deteriorates. The red, green, and blue phosphors age at different rates, eventually producing a color shift.

An important parameter affecting the color on a display is the white point. People tend to think of white as an absolute color. But there are actually many hues of white—compare the "white" light of the sun, an incandescent lightbulb, and a fluorescent light. The white point is important because it affects how you perceive all other colors on that display. Even more important is maintaining a consistent white point over time, because a white point that changes will throw off all the other colors on the screen. LCDs are excellent at maintaining a consistent white point, providing a predictable and uniform environment in which to view color images over time.

Managing color

Even with the color consistency now possible with flat-panel displays, for the most color-critical work it's still important to carefully manage the performance of every device in the workflow—cameras, scanners, displays, and printers. Because each device has different color reproduction capabilities, maintaining consistent colors in a given image from device to device is difficult without a systematic method of color control. That's why many creative professionals need a high-quality color management system.



Color management systems work by collecting information about every device and then using color correction to translate between the color characteristics of the different devices. Apple's own ColorSync technology is the industry's best means of managing color. It uses the industry-standard International Color Consortium (ICC) format for storing color information about different devices, known as the ICC profile. Creating a profile for a given device requires a calibrated measuring tool. The GretagMacbeth Eye-One and the MonacoOPTIX are two such tools. They can measure CRT and LCD displays, ensuring better long-term color fidelity in a color-managed workflow.

Apple Displays and SWOP Certification

With a calibrated Apple LCD, ColorSync, and a color-managed workflow based on Mac OS X, creative professionals and their clients can now evaluate print or electronic documents on the computer display, a more reliable, more accurate, cheaper, and faster method of proofing. Clients benefit from reduced costs and cycle times, and creative professionals gain a valuable competitive advantage, because they no longer have to create expensive hard-copy proofs or wait for overnight delivery services. Print publishers, designers, photographers, and art directors can share soft proofs via email or the web with full confidence that clients can see their work—even high-end color work—exactly as intended.

In January 2003, the Remote Director 2.0 proofing system from Integrated Color Solutions, Inc. (ICS) became the first display-based proofing system to be certified by SWOP (Specifications for Web Offset Publications; www.swop.org). The prestigious SWOP certification means Remote Director 2.0 can be used to approve jobs for press production onscreen without the need for hard-copy proofs. Remote Director 2.0 uses a 20-inch Apple Cinema Display, 23-inch Apple Cinema HD Display, or 30-inch Apple Cinema HD Display along with a Power Mac using Mac OS X. ICS chose Apple flat-panel LCDs because they are the only displays capable of providing the luminance and color gamut ICS needs to create an onscreen proof that has the same brightness and feel as paper.

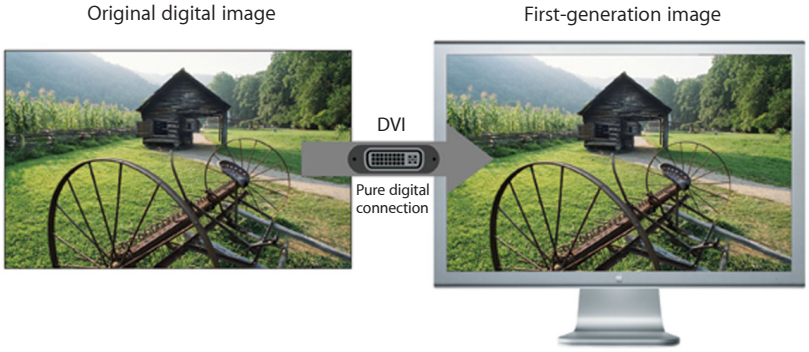
Pixel Response Time

For media professionals, the ability to render full-motion video or 3D graphics clearly enough to view precise details is key. Today's advanced LCDs, such as the Apple flat-panel displays, meet this demanding requirement. Apple LCD displays are designed to offer fast pixel response across the entire spectrum, working well with fast-moving details in multihued images.

Digital Connection

Some flat-panel displays still use an analog interface (typically VGA) to be more broadly compatible with graphics cards that don't support digital output. To create an analog signal from the digital data in graphics memory, the computer's graphics controller must perform a digital-to-analog (D/A) conversion. Because an LCD display is a digital device, the incoming analog signal requires conversion back to digital form (A/D). These two conversions (from digital to analog by the graphics card, then from analog to digital in the LCD monitor) inevitably lead to varying degrees of image degradation on the screen. This degradation can take many forms, including ghosting (fuzziness around the edges of images), color shifts, incorrect vertical and/or horizontal alignment of the viewable area, loss of vertical or horizontal synchronization, and brightness and contrast problems. Analog conversion problems become progressively worse as you move to monitors that have higher resolutions or use longer monitor cables.

Apple has maximized the sharpness of its displays by driving them with an industry-standard, pure digital signal based on the Digital Visual Interface (DVI) standard. This standard was created by the Digital Display Working Group (DDWG) to convert analog signals into digital signals to accommodate both analog and digital monitors. Data is transmitted using the Transition Minimized Differential Signaling (TMDS) protocol, providing a digital signal from the computer's graphics subsystem to the display.



The DVI standard specifies a single connector that handles two different digital signal bandwidths: single link and dual link. At 165MHz, the single-link bandwidth supports HDTV and UXGA (1600-by-1200-pixel resolution) display formats. The dual-link bandwidth (transmitted over a single cable) uses the same DVI connection, but it supports much higher resolutions, such as the 2560-by-1600-pixel resolution of the 30-inch Apple Cinema HD Display.

The pure digital connection of the Power Mac G5 to the Apple display ensures maximum visual quality. The NVIDIA GeForce 6800 Ultra DDL graphics card delivers two channels of dual-link support. By supporting dual 30-inch displays on the Power Mac G5, the GeForce 6800 Ultra DDL enables you to build the ultimate widescreen canvas.

Because of its exceptional resolution and the need for a dual-link DVI signal, the 30-inch Apple Cinema HD Display requires the ATI Radeon 9650 or NVIDIA GeForce 6800 Ultra DDL graphics card.* These cards' advanced graphics architecture and support for the dual-link digital signal make them ideal for driving the 30-inch Apple display. For customers who want to configure their systems with multiple 30-inch monitors, the NVIDIA GeForce 6800 Ultra DDL graphics card supports two 30-inch Apple Cinema HD Displays.

No controls required

To accommodate for the imperfections created by using an analog signal to drive a flat-panel display, manufacturers provide a lot of hardware and/or software user controls. But those controls are hard to use, and they can only do so much. When driving a digital display with an analog signal, it is particularly difficult to maximize the display's dynamic range, and therefore its ability to reproduce a wide range of colors is inhibited. Maximizing the range requires accurately establishing both the black and peak white points of the analog signal and the analog to digital converter. Often either the black point or the white point is set incorrectly, resulting in a decreased dynamic range or clipping of colors.

The pure digital DVI connectors of the Apple flat-panel displays transmit a digital signal from a digital location in the graphics card to a digital location on the display's screen, without requiring conversion. This digital connection gives you the full clarity and stability of liquid crystal technology—with sharp, clear pixels and no flicker. Because there's no conversion, there's no need for special controls. You see high-quality images every time, automatically, without having to constantly adjust the picture. For PC users, new controls on the side of the Apple displays make adjusting brightness a snap.

The following chart lists the controls needed for an LCD with an analog interface and those provided with an Apple all-digital display. In this case, needing more controls is not desirable.

User controls needed on an LCD without an all-digital signal	User controls on Apple LCD displays
Monitor startup and sleep	System wake and sleep
Brightness and contrast	Brightness
Fine tracking and coarse tracking (synch)	
White and black balance controls	
Horizontal and vertical positions	

PC Compatibility

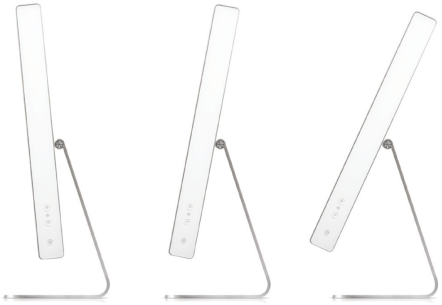
Apple flat-panel displays support the DVI standard and can therefore be seamlessly connected to a PC, without the need for an adapter. PC users can control the brightness of Apple LCDs using touch buttons on the side of the display.

The Apple display line also supports the VESA Display Data Channel (DDC) standard, allowing the displays to communicate their capabilities, such as the native resolution and refresh rates, to a graphics card in the PC. If the graphics card supports the full single-link or dual-link digital signal bandwidth required by Apple flat-panel displays, the PC's graphics subsystem will configure itself to work correctly with the display. The 20- and 23-inch Apple displays require a single-link DVI connection, and the 30-inch Apple display requires a dual-link DVI connection.

Stunning Design

In addition to providing outstanding visual performance, Apple displays are designed to be works of art. The elegant new bezel design coordinates with the aluminum enclosures of the Power Mac G5 and PowerBook G4, providing a stunning visual combination. The ultrathin bezel has an exceptionally narrow border that makes multiple displays fit together seamlessly for greater visual efficiency and productivity. Not only are the displays stunning to look at, but their design allows your eyes to focus on the screen rather than the enclosure. In addition, the color of the bezel has been carefully chosen to minimize interference with color appearing on the screen, providing a neutral reference point for viewing colors.

Adjustable hinge
Another important design feature is the unique smooth-motion hinge, which requires very little pressure to tilt the monitor to a different position. This design allows you to effortlessly adjust the display so you view it at a downward angle, a position that puts less strain on your eyes and neck.



Kensington security
The Kensington security port on the Apple displays allows you to secure the display using a Kensington locking mechanism. Because the port is located on the display itself, the lock can be used with the display stand provided or with an alternate mounting solution.

VESA mounting options
LCD displays have a tremendous advantage over CRT alternatives: Because of their thinner and lighter design, more customers are discovering innovative ways of using the displays, from integrating them into museum kiosks to mounting them on walls. The VESA mount feature supports the wide variety of VESA-compliant mounting solutions, allowing customers to configure the Apple displays in ways other than just on the desktop (requires VESA mount adapter, sold separately).

Integration

For many PC manufacturers, the display is a peripheral device. For Apple, the display is designed to be an integral part of a complete Mac or PC system. Our goal is to create systems that give you modular flexibility and all-in-one simplicity. For example, Apple flat-panel displays continue to feature a single-cable design that simplifies cable management. The cable elegantly splits out for easy connection to DVI, FireWire, USB, and power ports.

Apple flat-panel displays have the following integrated features that deliver smoother performance, more consistent operation, and easier setup and use than other LCDs:

- **DVI connector.** The industry-standard DVI connector allows easy connection of multiple Apple displays to Power Mac systems and PCs. PowerBook G4 users can now attach an Apple Cinema Display directly—without an adapter. Setup is a simple matter of plugging the display into the computer.
- **Single cable.** A single cable carrying power, video, and the USB and FireWire signals simplifies cable management and reduces clutter, an especially important consideration when using the display with alternate mounting devices such as articulating arms.
- **USB ports.** Dual USB ports make it easy to connect peripheral devices. Full support for USB 2.0 delivers faster I/O performance when using multiple peripherals.

- **FireWire ports.** Two FireWire 400 ports in addition to the USB ports allow you to attach digital video and still cameras, hard drives, scanners, an iSight camera, and more.
- **Power button.** The power button on the front of the display allows you to put the system to sleep or wake it up with a single touch.
- **Brightness control lockout.** If you're managing a creative workgroup, you want to ensure that brightness can't be adjusted after a display has been profiled and calibrated. The Displays preference pane in Mac OS X allows you to lock the brightness controls on the side of the monitor.

Support for Dual Displays

The Mac OS has supported extended desktop mode right from the start, a capability that is especially important for professional users. Whether you have a Power Mac G4 or G5 or a PowerBook G4 computer, you'll enjoy the benefits of having an additional Apple flat-panel display.* A second display dramatically increases the amount of "screen real estate" you have to work with, an advantage for graphic designers, video editors, and other media professionals who must juggle multiple source documents, tool palettes, timelines, and more. It's also a great solution for PowerBook users who want a larger screen when they aren't on the road.

Some Power Mac G5 systems have both an ADC port and a DVI port, allowing you to plug one Apple display directly into the DVI port and use a DVI to ADC adapter (sold separately) to connect a second display. Now the 15-inch and 17-inch PowerBook G4 systems support the extraordinary 30-inch Apple Cinema HD Display, giving your portable computer a dramatic desktop canvas. The 17-inch PowerBook is compatible right out of the box, with dual-link DVI support, 128MB of graphics memory, and the ATI Mobility Radeon 9700 graphics processor. You can also order the 15-inch PowerBook with these powerful graphics options.

Product Details

Apple Displays

Apple's all-digital flat-panel displays are available in three sizes to meet the needs of professional Macintosh users.

	20-inch Apple Cinema Display	**23-inch Apple Cinema HD Display**	**30-inch Apple Cinema HD Display**
Order number	**M9177LL/A**	**M9178LL/A**	**M9179LL/A**
Screen size and type	20-inch (viewable) active-matrix LCD	23-inch (viewable) active-matrix LCD	30-inch (29.7-inch viewable) active-matrix LCD
Maximum resolution	1680 by 1050 pixels	1920 by 1200 pixels	2560 by 1600 pixels
Viewing angle	170° horizontal; 170° vertical	170° horizontal; 170° vertical	170° horizontal; 170° vertical
Color support	16.7 million colors	16.7 million colors	16.7 million colors
Brightness	250 cd/m^2	270 cd/m^2	270 cd/m^2
Contrast ratio	400:1	400:1	400:1
Input/Output ports	DVI connector, two USB 2.0 ports, two FireWire 400 ports	DVI connector, two USB 2.0 ports, two FireWire 400 ports	DVI connector, two USB 2.0 ports, two FireWire 400 ports
Agency approvals	ENERGY STAR, TCO '03	ENERGY STAR, TCO '03	ENERGY STAR, TCO '03
Optional accessories	Cinema Display VESA Mount Adapter—compatible with VESA FDMI (MIS-D, 100, C) compliant mounting solutions; ADC to DVI adapter		

System Requirements

The 20-inch Apple Cinema Display and 23-inch Apple Cinema HD Display require one of the following:

- Power Mac G4 or G5 with Mac OS X v10.2.8 or later and an NVIDIA graphics card or ATI Radeon 7500 or better graphics card
- PowerBook G4 with Mac OS X v10.2.8 or later and DVI port
- PC with full-bandwidth single-link DVI port and DDC support

The 30-inch Apple Cinema HD Display requires one of the following:

- Power Mac G5 with Mac OS X v10.3.4 or later and an ATI Radeon 9650 or NVIDIA GeForce 6800 Ultra DDL graphics card. (The ATI Radeon 9650 is preinstalled in the dual 2.7GHz Power Mac G5. Both cards are available as build-to-order options for Power Mac G5 purchasers. The NVIDIA GeForce 6800 Ultra DDL is also available as an upgrade kit for Power Mac G5 owners. Note that the NVIDIA card occupies the AGP slot and the adjacent PCI slot.)
- PC with full-bandwidth dual-link DVI port and DDC support
- 1.67GHz 17-inch PowerBook G4 or 1.67GHz 15-inch PowerBook G4 with 128MB of video memory; Mac OS X v10.3.7 or later

Dual display support
The Power Mac G5 with the NVIDIA GeForce 6800 GT DDL or Ultra DDL graphics card supports two Apple displays (including two 30-inch displays). Other Power Mac G4 and G5 configurations support a second 20- or 23-inch Apple display (may require an Apple ADC to DVI Adapter, sold separately).

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. Power Mac and PowerBook customers can also enroll one display for coverage, provided that the display is purchased at the same time as the covered computer. For more information, visit www.apple.com/support/products.

Technical Specifications

Following are the specifications for the 20-inch Apple Cinema Display, the 23-inch Apple Cinema HD Display, and the 30-inch Apple Cinema HD Display.

Screen size

- 20-inch Apple Cinema Display: 20 inches (diagonal viewable)
- 23-inch Apple Cinema HD Display: 23 inches (diagonal viewable)
- 30-inch Apple Cinema HD Display: 30 inches (29.7 inches diagonal viewable)

Screen type

- Thin film transistor (TFT) active-matrix liquid crystal display

Resolutions

20-inch Apple Cinema Display

- 1680 by 1050 pixels (optimum resolution)
- 1280 by 800 pixels
- 1024 by 640 pixels

23-inch Apple Cinema HD Display

- 1920 by 1200 pixels (optimum resolution)
- 1280 by 800 pixels
- 1024 by 640 pixels

30-inch Apple Cinema HD Display

- 2560 by 1600 pixels (optimum resolution)
- 2048 by 1280 pixels
- 1920 by 1200 pixels
- 1280 by 800 pixels
- 1024 by 640 pixels

Display colors (maximum)

- 16.7 million

Viewing angle (typical)

- 170° horizontal; 170° vertical

Brightness (typical)

- 20-inch Apple Cinema Display: 250 cd/m^2
- 23-inch Apple Cinema HD Display: 270 cd/m^2
- 30-inch Apple Cinema HD Display: 270 cd/m^2

Contrast ratio (typical)
- 400:1

Response time (typical)
- 16 ms

Pixel pitch
- 20-inch Apple Cinema Display: 0.258 mm
- 23-inch Apple Cinema HD Display: 0.258 mm
- 30-inch Apple Cinema HD Display: 0.250 mm

Screen treatment
- Antiglare hardcoat

User controls (hardware and software)
- Display power
- System sleep and wake
- Brightness
- Monitor tilt

Cable connectors
- DVI (Digital Visual Interface)
- FireWire 400
- USB 2.0
- DC power (24.5V)

Ports
- Two-port, self-powered USB 2.0 hub
- Two FireWire 400 ports
- Kensington security port

VESA mount
- Requires Cinema Display VESA Mount Adapter (M9649G/A, sold separately)
- Compatible with VESA FDMI (MIS-D, 100, C) compliant mounting solutions

Electrical requirements
- Input voltage: 100–240 VAC; 50–60Hz
- Maximum power when operating:
  - 20-inch Apple Cinema Display: 65W
  - 23-inch Apple Cinema HD Display: 90W
  - 30-inch Apple Cinema HD Display: 150W
- Energy saver mode: 3W or less

Environmental requirements
- Operating temperature: 50° to 95° F (10° to 35° C)
- Storage temperature: –40° to 116° F (–40° to 47° C)
- Operating humidity: 20% to 80% noncondensing
- Maximum operating altitude: 10,000 feet

Agency approvals

- FCC Part 15 Class B
- EN55022 Class B
- EN55024
- VCCI Class B
- AS/NZS 3548 Class B
- CNS 13438 Class B
- ICES-003 Class B
- ISO 13406 Part 2
- MPR II
- IEC 60950
- UL 60950
- CSA 60950
- EN60950
- ENERGY STAR
- TCO '03

Size and weight

20-inch Apple Cinema Display

- Height: 16.1 inches (41 cm)
- Width: 18.5 inches (47.1 cm)
- Depth: 6.8 inches (17.4 cm)
- Weight: 14.5 pounds (6.6 kg)

23-inch Apple Cinema HD Display

- Height: 17.7 inches (45 cm)
- Width: 21.1 inches (53.6 cm)
- Depth: 7.3 inches (18.7 cm)
- Weight: 15.5 pounds (7.03 kg)

30-inch Apple Cinema HD Display

- Height: 21.3 inches (54.3 cm)
- Width: 27.2 inches (68.8 cm)
- Depth: 8.46 inches (21.5 cm)
- Weight: 27.5 pounds (12.5 kg)

For More Information

For more information about Apple's family of all-digital flat-panel displays, visit www.apple.com/displays.

*See System Requirements on page 22 for details.