



ColorSync in Mac OS X

Technology Overview

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Introduction

Color has the ability to communicate, to please, to excite, and to engage. Color makes a difference—often a dramatic difference—in our photographs, our graphics, and our layouts. Getting color right early in the workflow, and keeping it right to the end, is increasingly critical in our fast-paced, deadline-driven digital world. Yet photographers and designers are frequently dismayed when they print an image and the color is wildly contrary to expectations. These disruptive surprises cost time and money, while causing delivery delays and disappointed clients.

How can you make informed decisions during the production process so that the final result matches your intentions—and your client's expectations—especially when production involves multiple contributors in multiple locations using multiple applications and devices?

Mac OS X provides a robust, standards-based solution for color management. It's called ColorSync, Apple's universal color translator for delivering consistent and accurate color across devices and at all stages of production. With ColorSync integrated into Mac OS X and included at no additional cost on every Macintosh, it's quick, easy, and affordable to get started.

ColorSync extends the capabilities of creative professionals by making the management of color effective, predictable, and practical. Participants in the creative and production process will experience these benefits:

- Accurate color that matches expectations
- Consistent color over time, across media, and using multiple vendors
- Better coordination among distributed team members
- Reduced production timetables, based on shorter and fewer review cycles
- Reduced costs, based on greater efficiencies, fewer paper proofs, and less rework
- More satisfied clients, based on faster turnaround, lower costs, and higher-quality product

ColorSync and Mac OS X deliver on the promise of higher productivity through the accurate representation and consistent reproduction of color. The color you capture is the same color you see on the screen and in the finished printed product. No waste. No surprises. No disappointments.

How ICC Color Management Works

Today's creative workflows make use of a wide variety of imaging devices, such as digital cameras, scanners, printers, and computer displays. But for each device, the same combination of numerical values will yield a different color. For example, a single pixel where R=128, G=128, and B=128 should produce a completely neutral gray tone, but on some devices the gray will look warm, or reddish, and on others the gray will look cool, or bluish. These inherent disparities make it difficult to render the colors of an image from one device to another with consistency, accuracy, and predictability.

The International Color Consortium (ICC) was established to address this problem. Founded in 1993 by Apple and seven other vendors, the ICC now has a member base of more than 70 industry-leading manufacturers and software developers, including Sony, Hewlett-Packard, Creo, Adobe, and Quark. Their charter is to create and promote an open color management architecture and vendor-neutral file formats. At the core of their development efforts are the ICC profile and the Color Management Module (CMM). Both are designed to ensure consistent color between applications, across computing platforms, and across imaging devices.

Classes of ICC profiles

In addition to device profiles, the ICC has defined other classes of profiles. Named Color Profiles (NCPs) are used in spot-color systems such as PANTONE, DIC, and Toyo Ink. NCPs work in conjunction with other profiles to process colors more accurately and to produce more faithful results on the display, as well as on various printers. Another class of ICC profiles consists of abstract profiles, which are used to produce an effect, similar to a Photoshop adjustment layer.

The ICC Color Profile

Color management begins with the ICC profile, a cross-platform file format that defines the color data required for calculating a color match between devices or between working color spaces. Each ICC profile contains at least one pair of these numerical values:

- Device-dependent data (for example, unique combinations of RGB values)
- The device-independent color produced by the device values

The device-independent color information is also called the Profile Connection Space (PCS).

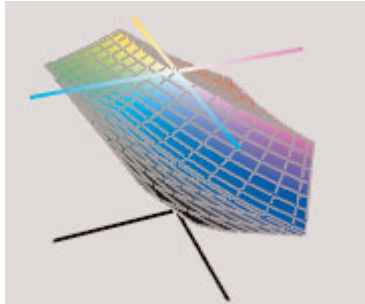
Some device profiles, including scanner profiles, can have only device-to-PCS color tables, because color only comes in from a scanner and out to other devices. Some profile classes, such as printing press profiles, can have both device-to-PCS and PCS-to-device tables.

Conversion examples

- To view a scanned image on a display:
 - Scanner RGB > PCS > Display RGB, using the scanner's device-to-PCS table and the display's PCS-to-device table
- To print the scanned image on a commercial printing press:
 - Scanner RGB > PCS > Press CMYK, using the scanner's device-to-PCS table and one of the press's PCS-to-device tables

Device Link Profiles

To remove the extra conversion step through the PCS, two device profiles—for example, for the press and the proofer—can be merged into one Device Link Profile using a tool such as ColorThink from CHROMiX, Inc. However, at this time not all applications and raster image processors (RIPs) support link profiles.

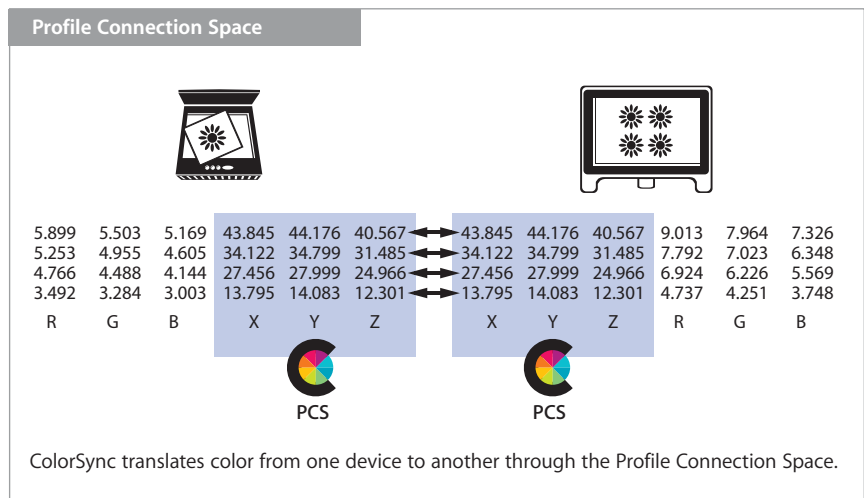


A device's gamut, the total number of reproducible colors, can be visualized as a 3D volume. Visualizing a device gamut in 3D is the most accurate way to see all the colors a device can produce. This can be seen using the ColorSync Utility.

- To print a proof of how the press will reproduce the scanned image:
 - Scanner RGB > PCS > Press CMYK, using the scanner's device-to-PCS table and one of the press's PCS-to-device tables; then Press CMYK > PCS > Proofer CMYK using one of the press's device-to-PCS tables and one of the proofer's (for example, Epson Stylus Pro 7600) PCS-to-device tables

The Color Management Module (CMM)

The Color Management Module, or CMM, is a mathematical engine that performs color transformations by connecting the source color space to the destination color space through the PCS. The CMM converts a source profile (for example, a scanner) to a destination profile (for example, ColorMatch RGB) through the common PCS.



To minimize the file size of device profiles, not every in-gamut color is included in the color tables. This means the CMM might need to interpolate a color value if one is not expressly defined in the destination profile. When the CMM encounters colors that do not overlap, or are out of gamut, it looks to the rendering intent to determine the best method of calculating the color transformation.

Rendering Intent

The rendering intent determines how the CMM will map colors from one device's color space to another's. Each ICC profile is tagged with a default rendering intent (usually perceptual); but the user might prefer to select a rendering intent from within an application, such as in Adobe Photoshop. The following four rendering intents are used to reflect different imaging requirements.

Perceptual. Reproduces the relationship between colors by scaling the entire source space into the destination space, including those colors that were in gamut. Perceptual intent produces the most pleasing color results and is generally recommended for continuous tone photographs, where reproducing exact hues is not necessary.

Saturation. Reproduces the relative saturation of colors from gamut to gamut for the brightest, most vivid results. Saturation intent is designed primarily for business graphics.

Relative colorimetric. Changes only the colors that fall outside the gamut of the destination device, often causing two colors that appear different in the source color space to be the same in the destination color space. Colors are scaled relative to the destination profile's white point; the whitest white of the source space is mapped to the whitest white of the destination space. In some instances, the relative colorimetric intent produces a more appealing result than the perceptual intent.

Absolute colorimetric. Matches in-gamut colors exactly, reproducing the white point of the source profile on the destination device, but clipping out-of-gamut colors to the nearest hue. Absolute colorimetric intent is best for rendering signature colors, such as Coca-Cola red or Eastman Kodak yellow, and is most useful for soft-proofing.

What Is ColorSync?



ColorSync features in Mac OS X v10.2

- Complete integration into the operating system
- Performance enhancements—twice as fast as in Mac OS 9
- New Apple CMM for superior image quality and performance
- Full compliance with the ICC version 4.0 standard
- High-quality default profiles
- Greater control over profiles using the ColorSync Utility

ColorSync is Apple's implementation of the ICC specification, providing system-level color management of images, documents, and devices. It is both an engine for processing color and a framework for handling color on disparate devices. ColorSync in Mac OS X v10.2 supports the current ICC specification, now at version 4.0, and can use all profiles from ICC version 2 forward, regardless of the operating system that created them.

Seamless Device Integration

ColorSync in Mac OS X effortlessly integrates all of your imaging devices, including scanners, digital cameras, displays, and printers. This capability is made possible by a device registration database in Mac OS X, which automatically registers at least one profile for every imaging device the moment it's first connected to a Mac OS X system. The profiles in the device registration database can be recognized and used by applications in the digital workflow. For example, using Image Capture, the color in an image downloaded from a digital camera is translated on the fly to the display when the file is opened in Preview, based on the profiles registered for the two devices. When printing from Preview, the color in the original image is matched to the printer's profile. ColorSync automatically matches color from input device to display to output device, adjusting the color characteristics and addressing the limitations of each device in the workflow. (See page 15 for more information about Image Capture and Preview.)

Complete Integration into Mac OS X

In Mac OS X, ColorSync is fully integrated into the operating system, ensuring that powerful color management tools can be accessed from every application. In fact, Mac OS X v10.2 is the only operating system that fully supports the ICC version 4 standard for managing color—delivering the industry's most advanced OS-level color management system. This integration makes it easy for developers to build color management features into their applications and create products for greater productivity and higher-quality results.

In addition, a new Apple CMM in Mac OS X has increased the speed and precision of color transformations. Matrix-based RGB-to-RGB color transforms take advantage of the power of the G4 Velocity Engine to dramatically speed up the most common color calculations; and the Apple CMM uses multiprocessing whenever possible for further performance enhancements. As a result, color matching in Mac OS X v10.2 is nearly twice as fast as in any previous version of the Mac OS.

Getting Started with ColorSync



Apple has been a leader in promoting and maintaining ICC-compliant color management since 1995. Most popular professional graphics applications, such as Adobe Photoshop, Nikon Capture, Corel Painter, and GretagMacbeth ProfileMaker Pro, take full advantage of the power of ColorSync and Mac OS X.

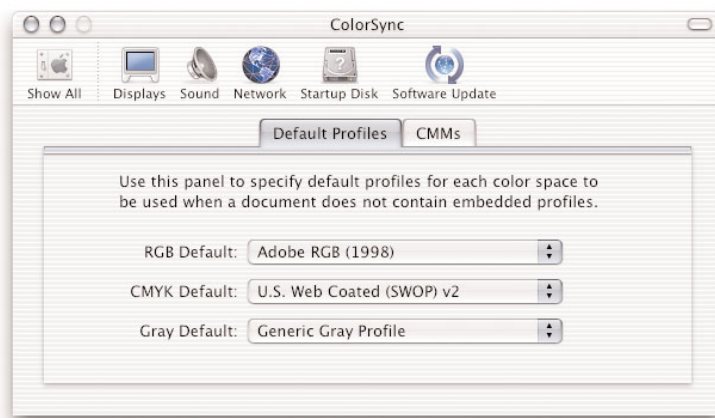
With ColorSync fully integrated into Mac OS X, it's quick and easy to start managing color—no complicated tricks or tools required. In fact, since ColorSync in Mac OS X is always on, you might be working with color-managed images without even knowing it. However, for better color results in a basic creative workflow, it's important to understand a few simple settings and procedures.

ColorSync Settings

Mac OS X v10.2 features a simplified System Preferences pane for ColorSync that allows you to set default profiles and CMMs, making them automatically available to all applications. To open the ColorSync preferences pane, choose System Preferences from the Apple menu and click the ColorSync icon.

Setting default profiles

The Default Profiles tab lets you assign profiles for documents that do not contain an embedded profile—so applications can always find a profile for every document.

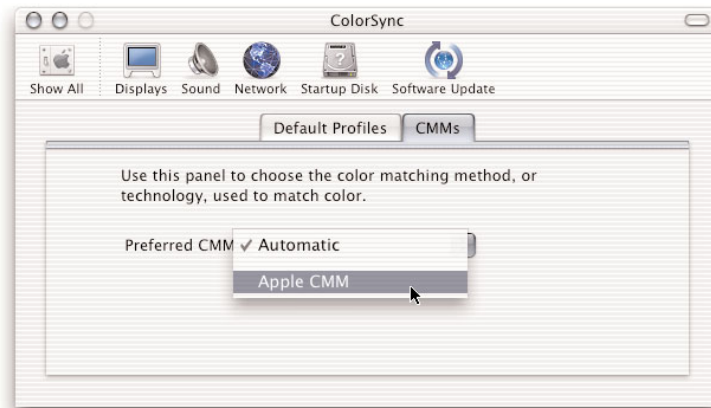


Images without embedded profiles are assigned high-quality profiles. (The profiles shown above can be downloaded from the Adobe website.)

The CMMs tab lets you choose the Color Management Module to use when calculating colors. If the CMM preference is left as Automatic, ColorSync uses the CMM specified in the source profile. Or you can choose the Apple CMM, which overrides the CMM specified in the source profile.

The new Apple CMM

At the heart of ColorSync in Mac OS X is a robust new CMM. It is the core mathematical engine that performs profile-to-profile color transformations. The Apple CMM works with available color profiles to display and print color more accurately and more dependably—without sacrificing performance.



Choose the Apple CMM to make consistent, accurate color available to all applications in Mac OS X.



Apple displays

Apple's industry-leading LCD displays are flicker-free, with twice the brightness, twice the sharpness, and twice the contrast of typical CRT displays. Unlike other flat-panel displays, they're designed with a pure digital interface to deliver distortion-free images and enable precision editing. Apple displays offer a depth of 16.7 million colors and let you see consistent color from a 170° viewing angle. For more information, see www.apple.com/displays.

Displays and Display Profiles

Whether you're a photographer or a designer, the display connected to your computer is the window to your work. That's why it's crucial to select a digital LCD display that represents colors faithfully—over a wide gamut and with little color deterioration over time. Frequent calibration and profiling are important, too. Mac OS X supports color profiling of the computer display, using either the built-in Display Calibrator or a third-party calibrator and profiling software.

Choosing a display

Traditionally, CRT monitors have played an important role in color proofing systems. In recent years, however, LCD technology has improved dramatically, giving LCD displays a distinct advantage over CRT displays in color-critical creative workflows. Today's best LCDs offer a wide color gamut, rivaling the best CRTs; excellent color uniformity over the entire screen, thanks to wide-viewing-angle technologies; a consistent white point, with less color deterioration over time; and higher brightness, crisper blacks, and superior sharpness. LCDs are also less sensitive to the negative impacts of worst-case viewing environments—such as very hot or very humid conditions—providing more accurate and more predictable color in all scenarios.

Color on LCD displays is further enhanced by an all-digital connection to the computer. Many LCDs rely on an analog interface (usually VGA); this interface requires signal conversions to the digital display, which can cause color shifts and problems in brightness and contrast. Analog conversion problems become progressively worse as you move to displays with higher resolutions or with longer cables. What's more, the controls used to drive a digital display with an analog signal often inhibit the display's ability to reproduce a wide dynamic range of colors. In contrast, all-digital connections do not require any conversion, providing a distortion-free signal for superior clarity and stability.

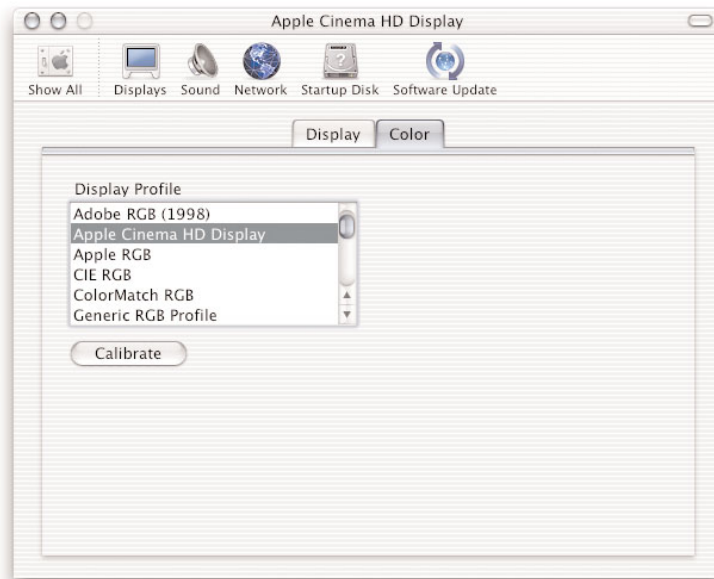
Display settings

As soon as you plug a display into a computer running Mac OS X, it communicates industry-standard Extended Display Identification Data (EDID) information to the system. Based on this information, ColorSync automatically creates a display profile—including the display's native gamma (such as 1.8) and color temperature (such as 6500°K)—that reflects how the display shipped from the factory.



Display Calibrator

The Display Calibrator is located in the /Applications/Utilities folder. You can open it either by double-clicking the application icon (shown above) or by clicking the Calibrate button in the the Displays preference pane.

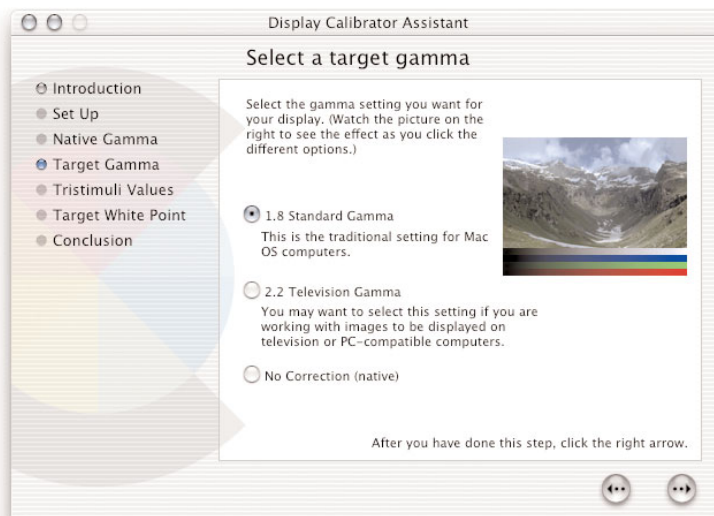


An existing display profile can be assigned at the system level using the Color tab in the System Preferences pane for Displays. Click the Calibrate button to open the Display Calibrator.

The Color tab also gives you access to the Display Calibrator, which enables Mac OS X to override the factory profile and create a profile that better conforms to your working environment. For example, you might want to change the white point from 6500°K to 5000°K, or the gamma from 1.8 to 2.2. The Display Calibrator walks you through a series of steps to adjust the brightness, contrast, and color balance—communicating with the display using industry-standard EDID signals to identify the display, its native phosphor set, and its native white point. The end product is a fully functional ColorSync profile that can be set as the display profile in System Preferences. By default, ColorSync matches color only to the primary display (where the menu bar appears); however, applications such as Photoshop can match to multiple displays using ColorSync.

Environmental considerations

The colors and lighting in your work space can affect how you see colors onscreen and in print. An evenly lit space (not too bright) and neutral colors provide the best viewing environment. A lightbox adds industry-standard lighting, enabling you and others on the team—including your clients—to view work under the same light. For even finer control, you can set the lightbox to match your display's luminosity and balance its color temperature.



The Display Calibrator steps you through the calibration process to create a new display profile.

Monitor calibration devices

Some color-critical workflows demand superior display consistency, requiring the use of an electronic calibration device—either a colorimeter or a spectrophotometer—to create fine-tuned custom profiles. A colorimeter measures the luminosity of a few specific colors. A spectrophotometer measures relative amounts of refracted light across the entire visible spectrum. Recent improvements in colorimeter technology make these devices an affordable choice for calibrating displays. Spectrophotometers are more expensive, but provide a more accurate reading of color data and greater versatility—since they can also be used to calibrate output devices. It's a good idea to calibrate a display at least once a month.

The most popular colorimeters and spectrophotometers are available for Mac OS X. For more information, see the Macintosh Products Guide at www.apple.com/guide.



The new ColorSync Utility makes it easy to work with profiles in the device registration database. The ColorSync Utility is located at `/Applications/Utilities/ColorSync Utility`.

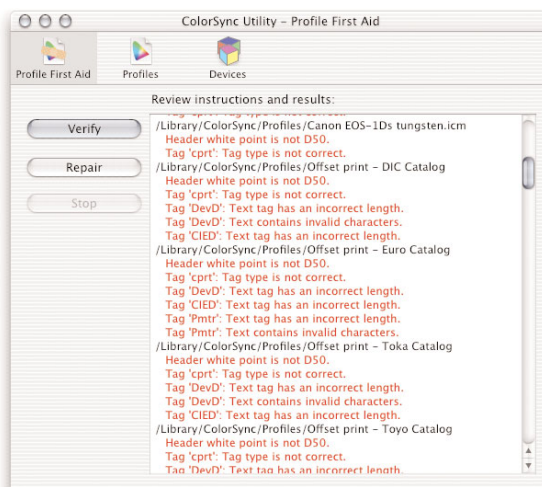
The ColorSync Utility

Every device connected to a Mac OS X system automatically registers a factory profile and a default profile in the system's device registration database. (For devices that register only one profile, the default and the factory profile will likely be the same.) In addition, a single device can have multiple modes—and therefore multiple profiles. For example, a digital camera can have one mode for shooting indoors and another for shooting outdoors. A printer can have a unique mode for each combination of media and resolution settings.

Mac OS X makes the device registration database available to any application that supports color management, enabling seamless device integration. The ColorSync Utility, included in Mac OS X, gives you direct access to the database—so you can verify profiles, repair them, edit them, and add custom profiles that match your project needs.

Verifying and repairing profiles

Using Profile First Aid, ColorSync prevents a corrupt or poorly written profile from bringing down your workflow. Profile First Aid verifies profiles in the database and checks them for validity or corruption. If a profile doesn't meet current specifications, its data is invalid, or a tag is written incorrectly, Profile First Aid diagnoses the problem and can repair it with the click of a button. Profile First Aid verifies only the format of the profile and does not verify the accuracy of the color it describes.



When you click the Repair button, Profile First Aid repairs invalid profiles, leaving them in good condition for use by ColorSync-capable applications.

Profile locations

ColorSync profiles are stored in several locations in Mac OS X. The operating system installs profiles in a read-only location: /System/Library/ColorSync/Profiles.

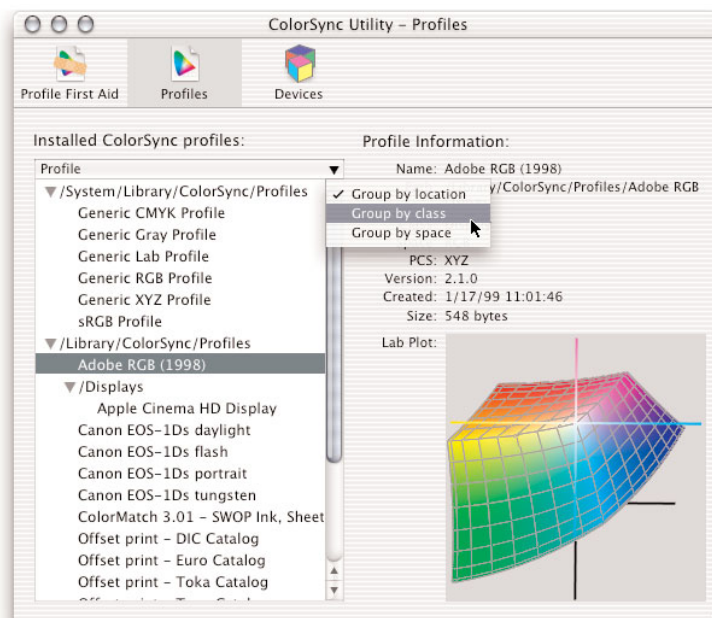
Other locations allow users to access and edit the profiles.

- For all users of the same Mac system:
/Library/ColorSync/Profiles
- For each individual user of the Mac system:
/Users/username/Library/ColorSync/Profiles (also referred to as
~/Library/ColorSync/Profiles)
- For access over a managed network:
/Network/Library/ColorSync/Profiles

Viewing and editing profiles

For greater control, the ColorSync Utility allows you to open and edit any profile and to substitute customized profiles for generic, “factory-made” device profiles. Click Profiles to display a list of all installed profiles. You’ll notice that every profile has an internal name that describes the device and its utilization, in addition to file names determined by the operating system that created them. For example, the file might have been named “pdcnycc.pf,” but its internal descriptive name is more complete: “KODAK Photo CD Color Negative V3.0.” You can also use the ColorSync Utility to inspect detailed information about each profile, including headers, tags, and color gamuts. You can even plot the gamut as a 3D shape—making it easy to compare the relative color spaces of different devices.

For more information about profile tags and other ICC specifications, see www.color.org.

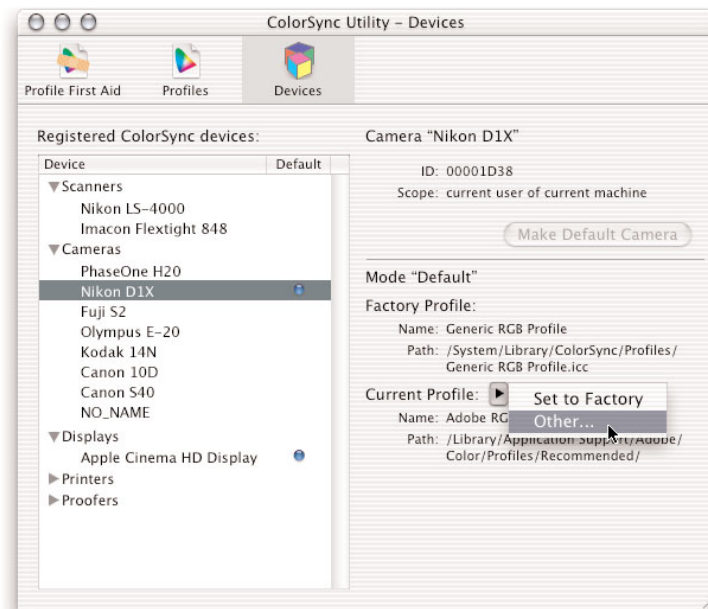


The ColorSync Utility categorizes devices by type in an easy-to-read list, similar to the Finder list view.

Creating custom profiles

The quality of factory profiles is usually sufficient for the level of accuracy required in most workflows. However, to better represent your utilization of imaging devices, the ColorSync Utility allows you to override the factory or default profiles and assign custom profiles to the devices in your workflow. Several ICC profile creation and editing applications are available for Mac OS X; see the Macintosh Products Guide at www.apple.com/guide.

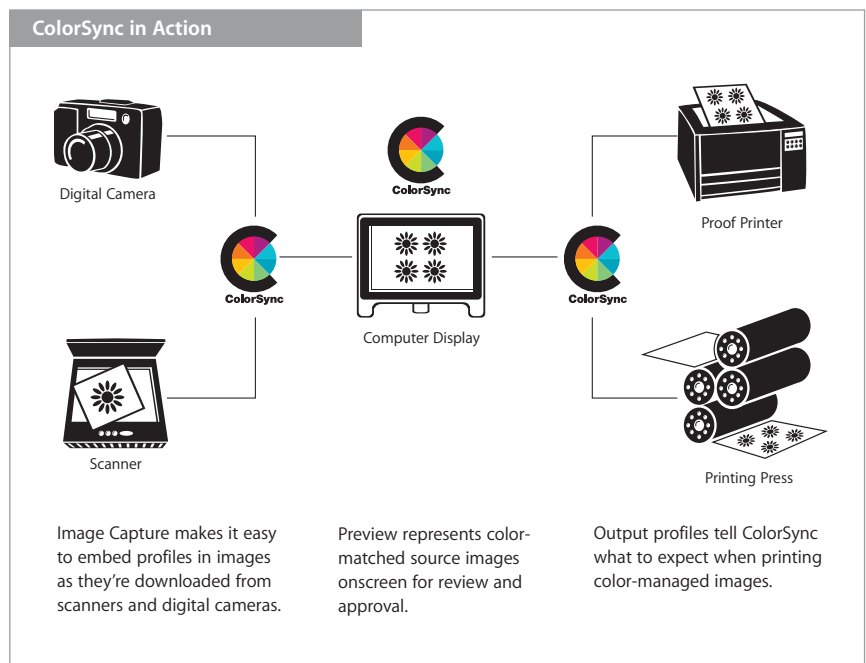
For example, if you frequently print photographs on your USB inkjet printer with a particular combination of ink and paper, you might create or obtain a custom ICC profile for this exact scenario, or mode. If you primarily use a particular mode, such as glossy paper and full resolution, you can use the ColorSync Utility to set that as the default mode. Each time you print using ColorSync, your printer will use this custom profile.



Click the Current Profile pop-up menu and select the profile you want to use whenever the device is in the corresponding mode.

Basic ColorSync Workflow

Mac OS X looks for an embedded profile in every image it displays, streamlining the most common color management workflows. The embedded profile tells the receiving application how the image appeared on the originating scanner, camera, or computer monitor—preserving its color quality and rendering it faithfully to its destination. The embedded profile moves with the image as it's transferred from one computer to another—making it possible to review and approve content across a workgroup, via email, or on the web. Since it represents the original captured image, and not necessarily the display of the originating computer, the embedded profile can have a significantly wider color gamut than that of the monitor used to create or view it.

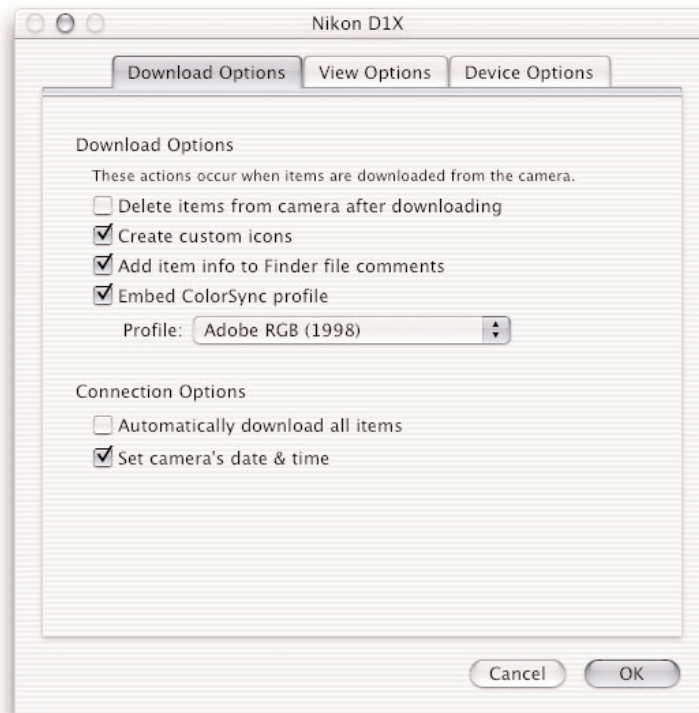


Embedding a profile in an image

Adobe Photoshop—and many other color-savvy applications—can embed, or assign, profiles to a document. Mac OS X also includes easy-to-use scripts for embedding profiles in an image. See `/Library/Scripts/ColorSync`.

Acquiring Accurate Color

Image Capture is a powerful application included with Mac OS X. Plug in virtually any digital camera based on popular standards such as Picture Transfer Protocol (PTP) and USB Mass Storage, and Image Capture opens and recognizes the device—without special drivers or image access software. By choosing a profile in the Image Capture pane, you embed a profile into images automatically as they're downloaded or scanned, overriding the device's factory profile. For even greater control, you can change the profile for each image, for each session, or as you add new devices to the system.



Choose a profile to embed in the image as it's being downloaded.

Image Capture also allows you to select the folder into which images are downloaded. And by selecting an AppleScript script to run as images are downloaded, you can fully automate your color management workflow—all within Image Capture. Just plug in your camera and let Mac OS X, ColorSync, and AppleScript do the work.

You can also attach scripts to folders; anytime you add a file to the folder, the script is activated. For example, you can set up a job folder and attach a script that converts downloaded images to a specific output profile. For more information about using AppleScript, see the "Automating ColorSync with AppleScript" section or visit www.apple.com/applescript.



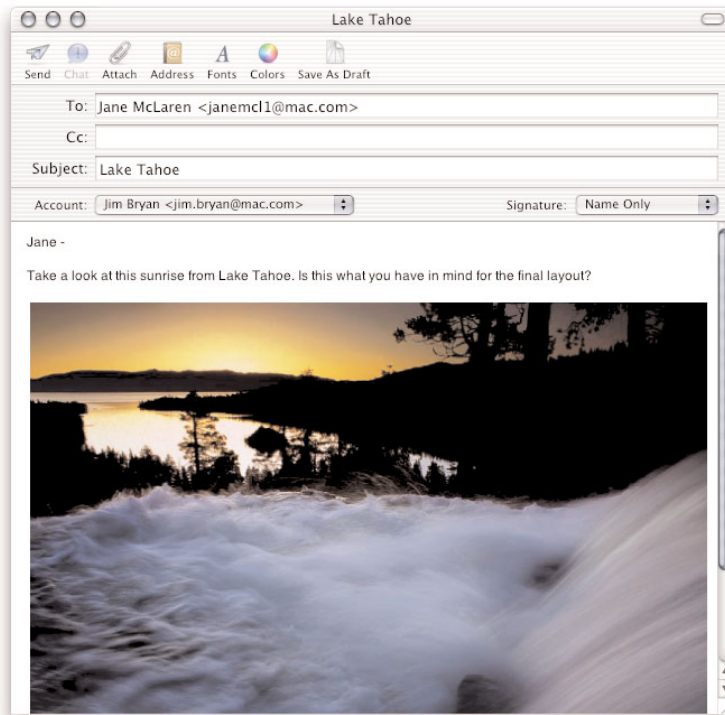
Preview

The Preview application comes with Mac OS X and is located in the Applications folder. Use Preview to open PDF documents and image files in a variety of formats. You can open it by double-clicking the application icon shown above.

Viewing Color-Managed Files

The Preview application included in Mac OS X uses ColorSync to render the source profile onscreen and when printing, making it possible to view and print color-consistent images across different displays and printers. There's no need to choose a profile, a CMM, or a rendering intent; the file is automatically color managed.

Preview can open most graphics file formats, including PDF, TIFF, and JPEG files. If Preview sees an embedded profile, it converts the source color space and renders it to either the current monitor profile or the output printer profile. If no profile is embedded, Preview uses Generic RGB Profile.icc, Generic CMYK Profile.icc, or another generic color space profile as the source color space. Other applications included with Mac OS X—such as Image Capture and Mail—also use ColorSync to deliver images with embedded profiles correctly to the display. This capability allows you to email color-accurate images or post them to your website, making it easy for clients to review and approve them onscreen.



Using Mail in Mac OS X, you can email images with embedded profiles.

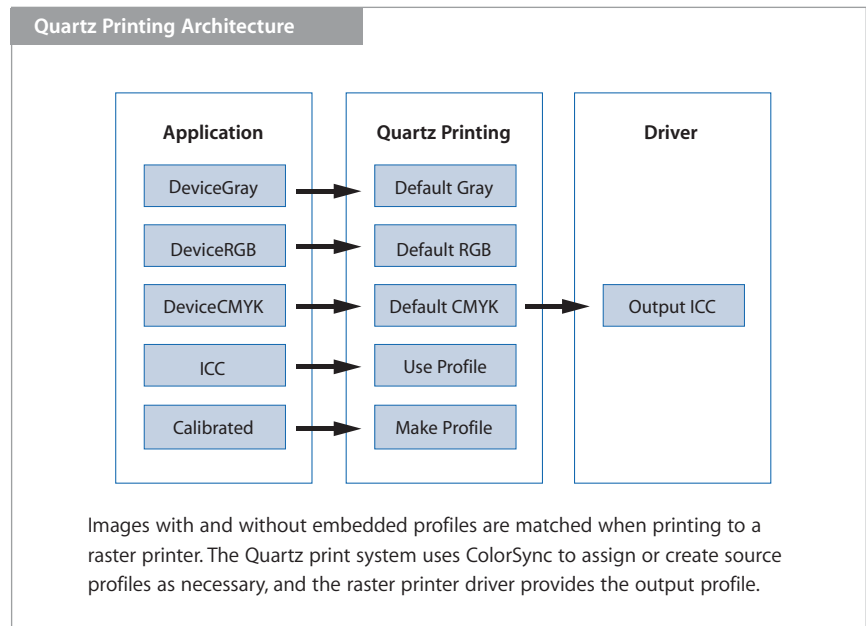
Apple's Keynote presentation application also recognizes embedded profiles. As with displays, most projectors send EDID information, so ColorSync can automatically create profiles for them and render the colors faithfully to the projector. A product from GretagMacbeth, called EyeOne Beamer, can even calibrate and profile projectors using the included EyeOne spectrophotometer.

For more control over color images, including simulating output devices onscreen and choosing CMMs and rendering intents for individual documents, see the "Putting ColorSync to Work" section.

Printing Color-Managed Files

Output profiles, or printer profiles, tell ColorSync what to expect when printing to the final destination device. Most printer manufacturers provide ICC profiles in their device drivers—improving the quality of color printed on their equipment without increasing the complexity of their software.

The new Mac OS X Quartz printing architecture is enriched with ColorSync technology. A document begins its path to a printer as a PDF spool file, which is prepared for printing based on information the computer receives from the printer. A source image without an embedded profile is tagged with the corresponding generic profile. When printing, ColorSync matches the source data to whatever profile has been provided by the printer driver. If a printer driver provides no profile, ColorSync matches the source data to the corresponding generic profile (usually Generic RGB Profile.icc) and then passes the data to the printer driver. This profile matching means that an image will look the same on all displays and will print the same from all systems—even without preexisting profiles. To make things even easier, Mac OS X has built-in drivers for many of the popular raster printers from Canon, Epson, and Hewlett-Packard.

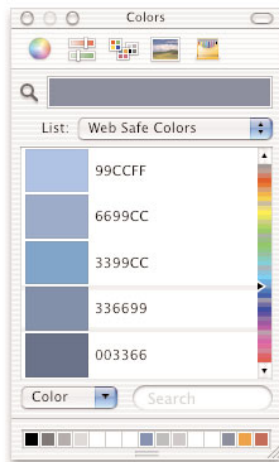


PostScript devices that use PostScript Level 2 and above also understand color management. When you print to a PostScript Level 2 or Level 3 device, ColorSync converts embedded ICC profiles to PostScript Color Space Arrays (CSAs) and has the printer convert color to the destination space, called a PostScript Color Rendering Dictionary (CRD). The CRD is the PostScript equivalent of an ICC output (printer) profile.

Putting ColorSync to Work

For more fine-tuned control over color transformations, many creative applications provide sophisticated tools for managing color from document source to destination. For example, Adobe Photoshop allows you to specify how to open color-managed documents and enables you to assign profiles.

To illustrate how to get the most out of ColorSync in Mac OS X, this section uses Adobe Photoshop 7.0—since its color management tools are representative of other Adobe applications, as well as other popular applications for creative professionals.



The Apple Color Picker

The Apple Color Picker is available to any application, including the Finder. Each application provides access to the picker in its own way; most Mac OS X applications now use the Colors icon. Select the Lists picker, then choose any installed Named Color Profile (NCP) from the List pop-up menu. In the example above, the Web Safe Colors NCP is selected.

Setting Up for Success

With a few simple steps in Color Settings, in the Photoshop menu, Photoshop can help you establish consistent practices for color management across your workgroup. You can configure Photoshop to use the ColorSync preferences you set in System Preferences. Or you can use your ColorSync preferences as the basis for an Adobe Color Settings File (.csf), which can be inherited by all Adobe applications once it's saved using Photoshop.

RGB setup

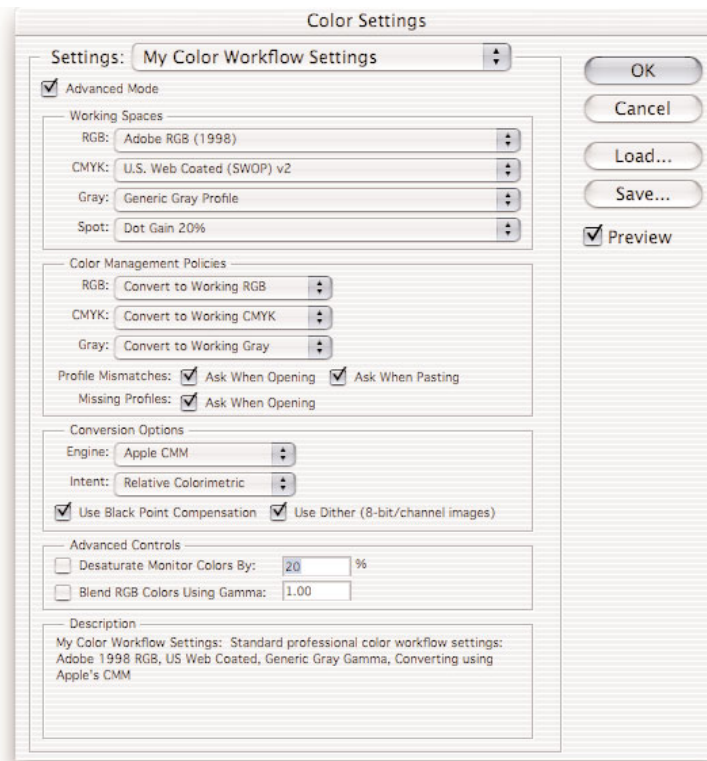
Photoshop gives you predefined, device-independent RGB working spaces. You can customize your working space using the RGB pop-up menu in the Color Settings pane. Select the default source RGB working space for colors you create using RGB color pickers and for RGB images with no embedded source profile. Adobe RGB (1998) and ColorMatch RGB are popular spaces for photographers.

Photoshop automatically provides the conversion from the selected RGB working space to your individual display. This conversion allows everyone in your workgroup to see the same color onscreen—provided they keep their displays calibrated and set Photoshop to the same RGB working space.

CMYK setup

Open the CMYK pop-up menu and choose your press, proofer, or standards-based CMYK profile for colors you create using CMYK color pickers and for CMYK images with no embedded profile.

The recommended set of RGB and CMYK profiles is available for download from the Adobe website, making these high-quality profiles available to any application in Mac OS X. Or ask your printer to provide you with profiles for its devices.



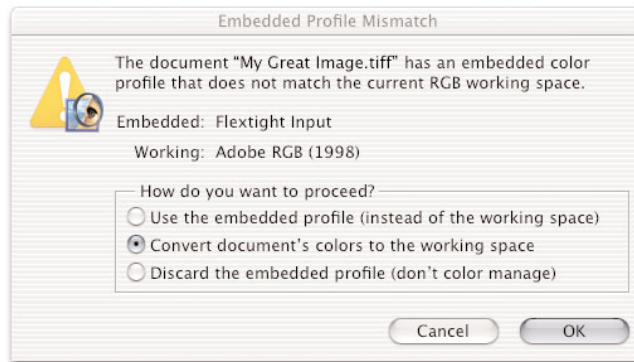
Photoshop Color Settings enable you to configure your working spaces and set application-wide color management policies.

Color management policies

Photoshop enables you to set application-wide color management policies. The Preserve Embedded Profiles option lets you open and save documents using their original embedded document profile. This profile becomes the source space for your document, rather than the working source space for the color model. Using Missing Profiles and Profile Mismatches, you can also tell Photoshop how to handle a document without a profile or with a profile that doesn't match your current working space.



When you open an image without an embedded profile, Photoshop can notify you and give you the opportunity to assign it a profile. (See “Assigning profiles” on the next page.)



When you open an image that uses a different color space from your working space, you can choose to preserve the embedded profile or to convert the profile to match your current working space.

Working with Color-Managed Files

While Color Settings enable you to set applicationwide choices, Photoshop also enables you to manage color as you work with individual documents.

Assigning profiles

Using Image > Mode > Assign Profile, you can assign a selected profile to an image. Particularly useful for shared documents, this embedded profile remains with the image as it moves from your computer to any other application or device. Assigning a profile to an image defines how the pixel values in the file should be interpreted, but does not alter the image data in the file. You can experiment using ColorSync scripts or Photoshop to embed (or assign) different profiles to copies of the same image, and evaluate how each profile affects the color.

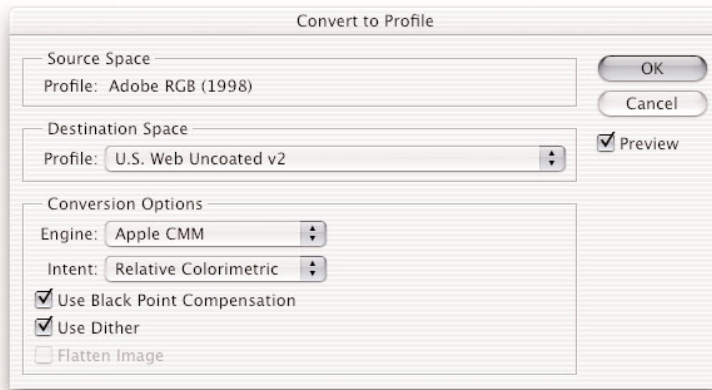


Choose a profile to be assigned to, or embedded in, the document.

Converting profiles

Using Image > Mode > Convert to Profile, you can convert an image's colors to a selected profile. Conversion alters the image data in the file, so the numbers produce the right color in the destination color space.

Photoshop allows you to specify a CMM to perform the color conversion. If you select ColorSync, the application will use whatever CMM you set in the ColorSync System Preferences pane. The Convert to Profile pane also lets you change the rendering intent, which gives the CMM the appropriate algorithm for profile-to-profile color mapping; the default intent is from the source profile.



Choose a CMM from the Engine menu and a rendering intent from the Intent menu.

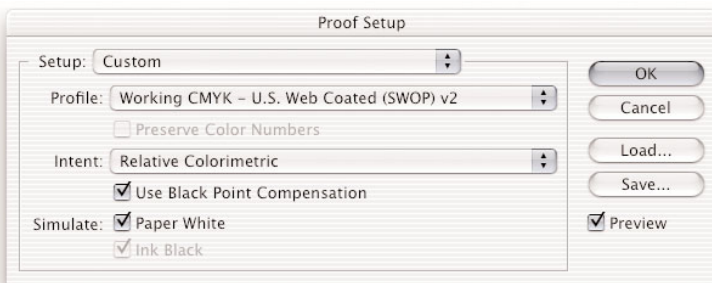
Facilitating client approvals

Mac OS X applications—Mail, Safari, and Preview—enable you to email or post documents for client viewing, without requiring them to use Photoshop. If you've converted the document to the profile of the final printer, your clients can see color onscreen that will be representative of the printed result. In addition, clients with supported printers can print color-accurate proofs from their desktops—with no add-on hardware or software required.

Soft-Proofing for Review and Approval

Soft-proofing means using the display to accurately represent the color of the final output. Soft-proofing over the Internet can eliminate days from a production schedule, especially when content creators and clients are distributed across the country or around the globe. Adobe Photoshop builds on the capabilities of Mac OS X to enable graphic designers, prepress houses, and printers to deliver an effective soft-proofing solution.

Start by using View > Proof Colors to turn on soft-proofing in Photoshop. Next, using View > Proof Setup > Custom, you can select the profile of the ultimate output device as well as your rendering intent. This step enables Photoshop to simulate a color-correct version of the final printed piece to the screen. Depending on the profile, you can even choose to simulate white paper and black ink.



Choose a profile and a rendering intent to create a soft proof of your document.

Printing PDFs

Mac OS X makes it easy to “print” a file to disk, using the Save As PDF function, instead of printing to an actual printer. In this case, a PDF file is created, retaining all associated profiles. Applications and systems that support and print PDF documents—such as Adobe Photoshop—can acknowledge the embedded profiles and use them to reproduce the document in correct, managed color.

When saving an image without an embedded profile as a PDF file, ColorSync automatically embeds the appropriate generic profile:

Generic RGB Profile.icc for RGB images;
Generic CMYK Profile.icc for CMYK images;
and Generic Gray Profile.icc for gray images.

Working with Output Profiles

A printer profile describes a combination of the printer, its substrate, and colorants (inks or dyes). Many types of output devices are used with—and their corresponding profiles are used in—Mac OS X:

- Printers that use four process colorants, typically cyan, magenta, yellow, and black (CMYK)
- Printers that use inks, dyes, and other colorants
- Printers that use red, green, and blue (RGB) signals, or an additive color system, such as photographic film recorders or computer displays

Printer profiles are usually quite stable and will describe the capabilities of the device for an extended period of time. If anything in the process changes significantly—substrate, colorant type, or the device itself—it’s a good idea to obtain or make a new profile. Creating a new profile generally involves printing a special “target” and measuring the color on the printed piece with a measurement device called a spectrophotometer. Profiling software analyzes the device and builds a printer profile that represents its characteristics and provides the mathematical data required for color calculations.

Once you’ve created a printer profile, you can save it in one of your ColorSync folders (such as /Library/ColorSync/Profiles/) to make it available to all applications using ColorSync. In addition, printer settings, profiles, and characteristics can be saved and recalled at any time in Mac OS X using saved settings.

Automating ColorSync with AppleScript

Built-in color management scripts

Mac OS X provides scripts for these common color management tasks:

- Build profile into web page
- Change display profile
- Embed chosen profile
- Embed display profile
- Embed specific profile
- Extract profile
- Match to chosen profiles
- Match to CMYK
- Match to specific profiles
- Mimic PC monitor
- PC to Mac Gamma
- Proof CMYK on display
- Proof to chosen profiles
- Proof to specific profiles
- Remove profile from image
- Rename profile
- Set profile info
- Show profile info

AppleScript is Apple's tool for automating applications and workflows within the Mac OS. Its unique ability to query and control applications makes it perfect for working with ColorSync and ICC profiles. In fact, Mac OS X includes scripts for common color management tasks, such as embedding a chosen profile in an image, removing a profile from an image, and displaying information about an embedded profile. These scripts have been saved as droplets in Mac OS X, which means you can simply drag an image or a profile onto the droplet icon to trigger the selected task. All built-in color management scripts can be found in `/Library/Scripts/ColorSync/ColorSync/`.

Attaching Scripts to Folders

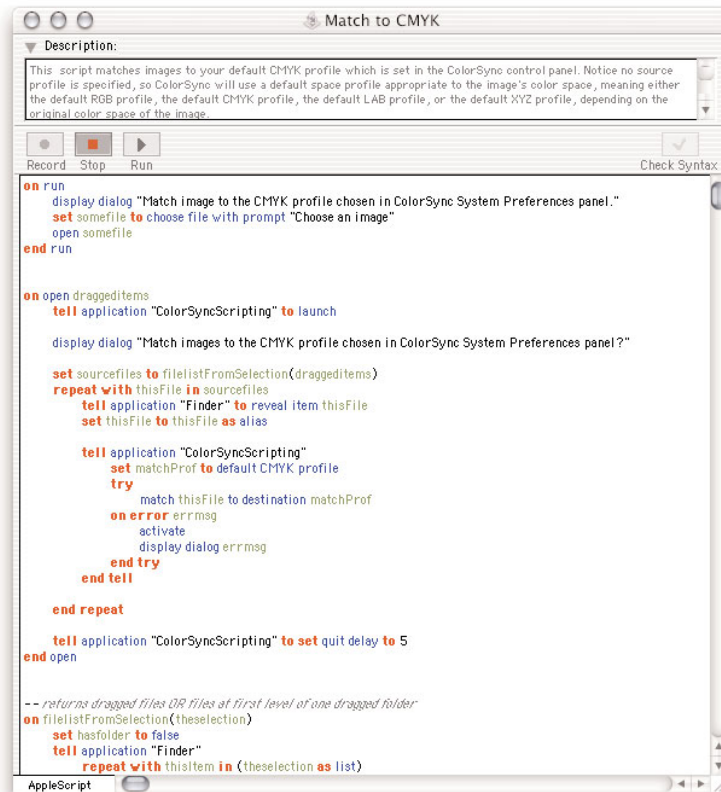
It's also possible to attach any color management script to a folder using Folder Actions in Mac OS X. Folder Actions enable a folder to activate a script when something related to the folder changes. For example, you can attach the "Convert to specific profile" script to a job folder, and any image placed in the job folder will be automatically converted to the profile you've specified in the script (for example, a press profile).

Folder Actions are easy to set up using the AppleScript menu. To add AppleScript to your Mac OS X menu bar, go to `Applications > AppleScript` and drag the file "Script Menu.menu" to the menu bar. The AppleScript scroll icon appears toward the right of the menu bar. Using the AppleScript menu, go to `Folder Actions > Attach Script to Folder` and follow the prompts to choose a script and a folder.

Creating Custom Scripts

Since AppleScript uses an English-like syntax, it's easy to learn—even for nonprogrammers. To get started, you can open the included scripts using Script Editor in Mac OS X and copy or modify code. Custom scripts can save you time, labor, and headaches in everyday work.

Using AppleScript Studio, you can combine the power of AppleScript and ColorSync with the look and feel of Mac OS X to create custom color workflow tools to share with your workgroup. For more information, visit www.apple.com/applescript.



```
Match to CMYK
Description:
This script matches images to your default CMYK profile which is set in the ColorSync control panel. Notice no source profile is specified, so ColorSync will use a default space profile appropriate to the image's color space, meaning either the default RGB profile, the default CMYK profile, the default LAB profile, or the default XYZ profile, depending on the original color space of the image.

Record Stop Run Check Syntax

on run
    display dialog "Match image to the CMYK profile chosen in ColorSync System Preferences panel."
    set somefile to choose file with prompt "Choose an image"
    open somefile
end run

on open draggeditems
    tell application "ColorSyncScripting" to launch
    display dialog "Match images to the CMYK profile chosen in ColorSync System Preferences panel?"
    set sourcefiles to fileListFromSelection(draggeditems)
    repeat with thisFile in sourcefiles
        tell application "Finder" to reveal item thisFile
        set thisFile to thisFile as alias

        tell application "ColorSyncScripting"
            set matchProf to default CMYK profile
            try
                match thisFile to destination matchProf
            on error errmsg
                activate
                display dialog errmsg
            end try
        end tell
    end repeat
    tell application "ColorSyncScripting" to set quit delay to 5
end open

-- returns dragged files OR files at first level of one dragged folder
on fileListFromSelection(theSelection)
    set hasFolder to false
    tell application "Finder"
        repeat with thisItem in (theSelection as list)
```

The "Match to CMYK" script matches an image to your default CMYK profile, as defined in your ColorSync Preferences. Using Script Editor, you can easily customize the script by replacing "default CMYK profile" with a standards-based profile of your choice.

Additional Resources

For more information about how to use ColorSync in Mac OS X, we recommend the following websites and books.

Websites

- ColorSync: www.apple.com/colorsync
- Mac OS X: www.apple.com/macosx
- Apple displays: www.apple.com/displays
- AppleScript: www.apple.com/applescript
- Macintosh Products Guide: www.apple.com/guide
- Adobe technical guides: www.adobe.com/support/techguides/color
- Adobe profiles: www.adobe.com/support/downloads
- International Color Consortium (ICC): www.color.org

Books

- *Real World Color Management*, by Bruce Fraser, Chris Murphy, and Fred Bunting
- *Real World Adobe Photoshop 7*, by David Blatner and Bruce Fraser
- *Mastering Digital Printing: The Photographer's and Artist's Guide to High-Quality Digital Output*, by Harald Johnson
- *Photoshop Color Correction*, by Michael Kieran
- *Adobe Photoshop 7.0 for Photographers*, by Martin Evening
- *Adobe Photoshop Master Class*, by John Paul Caponigro