Nikon Color Management

The Nikon Color Management System, or Nikon CMS, ensures that image data from Nikon scanners are reproduced consistently and accurately on monitors or printers. With this powerful tool, colors can be manipulated in a calibrated RGB color model before the data are passed to the host application. Profiles detailing the color characteristics of the chosen color model and the output device (monitor or printer) ensure that colors will be reproduced accurately in almost any operating environment.

Nikon CMS involves two categories of preferences, one ("Gamma") for use when Nikon CMS is off and the other ("Color Management") for use when Nikon CMS is on. "Gamma" specifies how data from the scanner will be modified for display on the monitor. Because monitor profiles can not be used when Nikon CMS is off, this adjustment must be made manually. "Color Management" is used to turn Nikon CMS on and off and select the profiles for use with the monitor and with the CMYK and calibrated RGB color models when Nikon CMS is on.

CMYK

Images can not be scanned in CMYK. If CMYK data are required, convert images to CMYK before saving them to disk. Note that images can only be saved in CMYK if Nikon CMS is on (Nikon CMS is on by default).

Turning Nikon CMS Off

In general, much better results can be achieved with Nikon CMS on. It may however be necessary to turn color management off to:

- **Speed processing**
  If the computer has a slow CPU, the processing required for color management may result in longer scan times. Try turning color management off for reduced scan times.

- **Edit data from the scanner directly**
  Advanced users may want to turn Nikon CMS off to edit uncalibrated RGB data from the scanner.

How Nikon CMS Works

When image data are passed from an input device, such as a scanner, to an output device, such as a monitor or printer, color management ensures that the image displayed on the output device "looks the same" as the original. To accomplish this task, the color management system must have information about the color characteristics of both the input and output devices, as well as the color space used for editing. The files containing this information are called "ICC profiles." Nikon Scan uses the following three types of profile:

Input Profiles

Input profiles provide information on the input device, i.e., the Nikon scanner. Fixed profiles detailing the color characteristics of supported Nikon scanners are provided with Nikon Scan. An input profile is selected automatically based on the model of scanner used and the type of media (positive or negative) being scanned.

Color-Space Profiles

Separate profiles are available for the RGB and CMYK color models. Nikon Scan comes with a selection of profiles for the RGB color model, while CMYK profiles for color printers are usually provided by the manufacturer. Color-space profiles are used when editing images in the scan window and when making the final scan.

Monitor Profiles

Monitor profiles are usually provided by the manufacturer, although profiles for some common monitor types may be included with the computer operating system.   Monitor profiles apply when images are displayed on a monitor, for example when an image is displayed in the preview area or an image window.

Creating Monitor Profiles

If desired, Adobe Photoshop can be used to create a monitor profile for a specific environment. This profile can then be used in Nikon Scan. For information on creating monitor profiles, see the documentation provided with Adobe Photoshop. This option is not available in Adobe Photoshop LE.
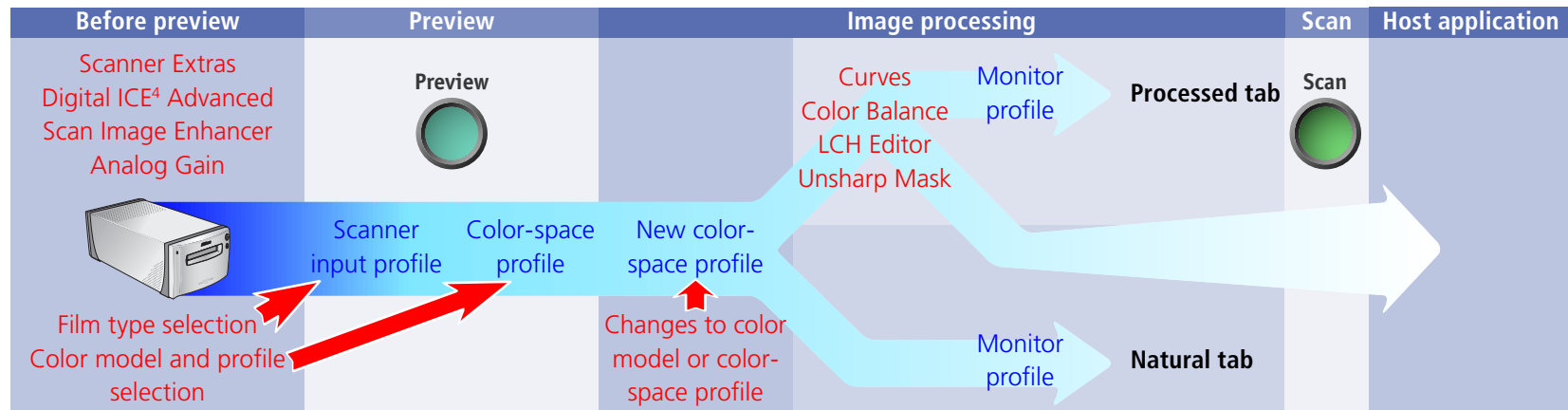
The Scanning Process

The illustration below shows the role Nikon CMS plays in the scanning process. CMS profiles are shown in blue, user operations in red.

When Nikon CMS is on, uncalibrated RGB image data from the scanner are converted to grayscale or calibrated RGB, depending on the color model selected in the scan window. RGB data are processed according to the profile selected for the calibrated RGB color space. These data are stored in memory so that the color model can be changed without performing another preview. Any changes made using the color enhancement and Unsharp Mask tools also apply to these data. When the image is displayed in the preview window, the monitor profile is used to ensure that the preview image is as true as possible to the data in memory.

When the **Scan** button is clicked to perform the final scan, the scan data are processed according to the selected color-space profile and any changes that were made using the color enhancement and Unsharp Mask tools in the scan window. The data are then transferred to the host application. Where possible, the color-space profile is transferred to the host application together with the image data. The TWAIN interface used in Windows, however, does not allow profiles to be passed to another application, with the result that under Windows the profile is only transferred to the host when Nikon Scan is used as a "stand-alone" application (note that profile information is lost when the image is saved in a format such as BMP that does not allow the profile to be recorded). When images are displayed in image windows in Nikon Scan, the monitor profile ensures that the image on the screen reflects the original as closely as possible.

Before preview	Preview	Image processing	Scan	Host application
Scanner Extras Digital ICE⁴ Advanced Scan Image Enhancer Analog Gain	Preview	Curves Color Balance LCH Editor Unsharp Mask	Monitor profile → Processed tab	Scan
	Scanner input profile — Color-space profile	New color-space profile		
Film type selection Color model and profile selection		Changes to color model or color-space profile	Monitor profile → Natural tab	

## Scanning with Nikon CMS Off

If **Use Nikon Color Management System** is not selected in the "Color Management" category, profiles can not be used to ensure that the data from the scanner are reproduced accurately when passed to another application or displayed in the monitor. Because the color profiles required for a calibrated RGB color space are not available when Nikon CMS is off, images can only be scanned as uncalibrated RGB or gray-scale. Similarly, the absence of a monitor profile means that gamma adjustment must be used to correct the image for display on the monitor or for editing in another application. These adjustments to gamma are made in the "Gamma" category of the "Preferences" dialog.

The illustration below shows how scanning proceeds when Nikon CMS is off. The image shown in the preview window is adjusted for display in the monitor according to the value chosen for preview gamma in the "Gamma" category. When the **Scan** button is clicked, the main scan gamma and any changes to curves and color balance are passed to the scanner, where they are applied to scan data before the image is transferred to the host application (if Nikon Scan is used as a "stand-alone" application, the value for preview gamma is passed to the scanner instead of main scan gamma). The LCH Editor and Unsharp Mask tools can not be used when Nikon CMS is off.
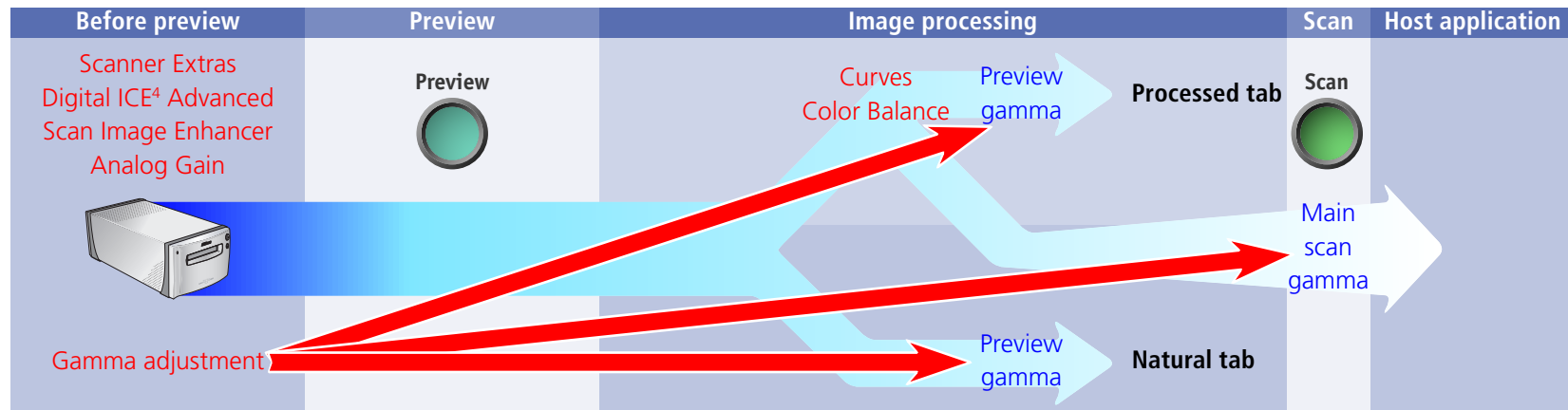
Gamma

When the **Use Nikon Color Management System** option in **the "Color Management" category (⊙ 84)** is off, the controls in the "Gamma" category are used to adjust data from the scanner so that they display correctly when previewed on the monitor or opened in another application.
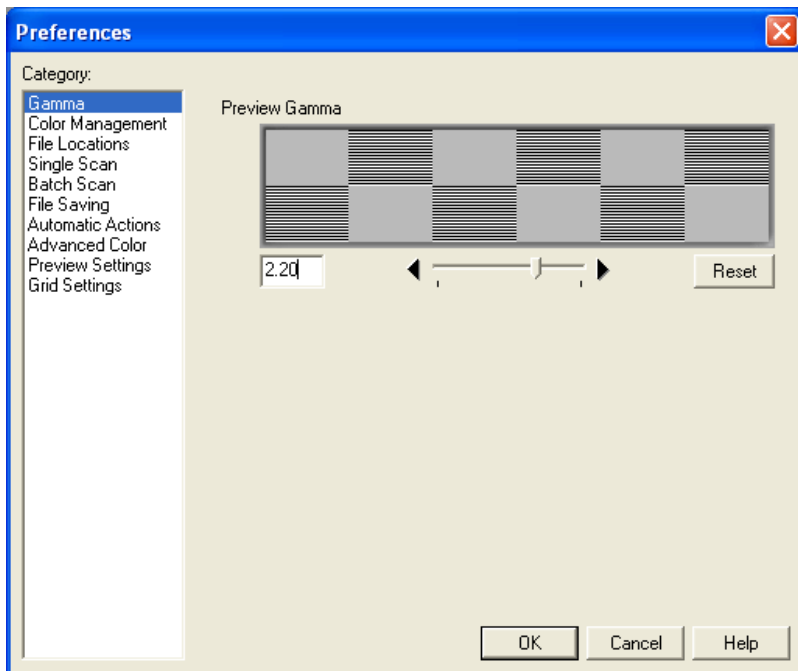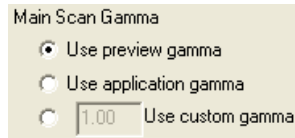

Preview gamma

Preview gamma applies to the image displayed in the preview area of the scan window. In general, preview gamma is solely for display in the preview area and does not apply to the image data that are passed to the host application when the **Scan** button is clicked. There are two exceptions to this rule, however. The first is when Nikon Scan is used as a "stand-alone" application, the second when **Use preview gamma** is selected as the main scan gamma option. In these cases preview gamma is applied to image data passed to the host application.

Preview gamma defaults to a value of 1.8 on the Macintosh, 2.2 on Windows computers. To choose a setting suited to the current monitor, adjust the value so that the patterns of gray lines and dots above the slider match in density. Gamma can be set by entering a value directly into the text box or by moving the slider. When making this adjustment, set the resolution on the monitor to a low value such as 640×480 and sit as far away from the monitor as possible. To restore the default setting for your platform, click **Reset**.

Main scan gamma

Main scan gamma options are only visible when Nikon Scan is being used as a TWAIN source or acquire plug-in for another program (when Nikon Scan is used as a "stand-alone" application, preview gamma automatically applies both to the preview image and to the final scan). Image data passed to the host application are modified according to the option chosen here. Three options are available:

Use preview gamma
The gamma value chosen for preview gamma is applied before the data are passed to the host application. Use this setting when the host application does not support independent gamma settings and you want the final image to be modified for display on your monitor.

Use application gamma
In some environments, a value for gamma can be chosen in the host application and passed to the Nikon Scan plug-in. When **Use application gamma** is selected, this value is applied to the main scan data before they are passed to the host application.

Two conditions must be fulfilled if this option is to be effective. First, the interface between the application and Nikon Scan must allow the gamma value to be passed to the Nikon Scan plug-in. The TWAIN interface used under Windows does not, however, allow the gamma value to be passed to the TWAIN source (i.e., to Nikon Scan). Consequently, in the Windows version of Nikon Scan a default value of 2.2 is used for main scan gamma whenever **Use application gamma** is selected. Second, the application must support gamma transfer. If **Use application gamma** is selected with a Macintosh application that does not support this feature, Macintosh system gamma (1.8) will be used.

Use custom gamma
When this option is selected, a value for main scan gamma can be entered in the text box.

Color Management

The profiles used by the Nikon Color Management System are specified in the "Color Management" category.
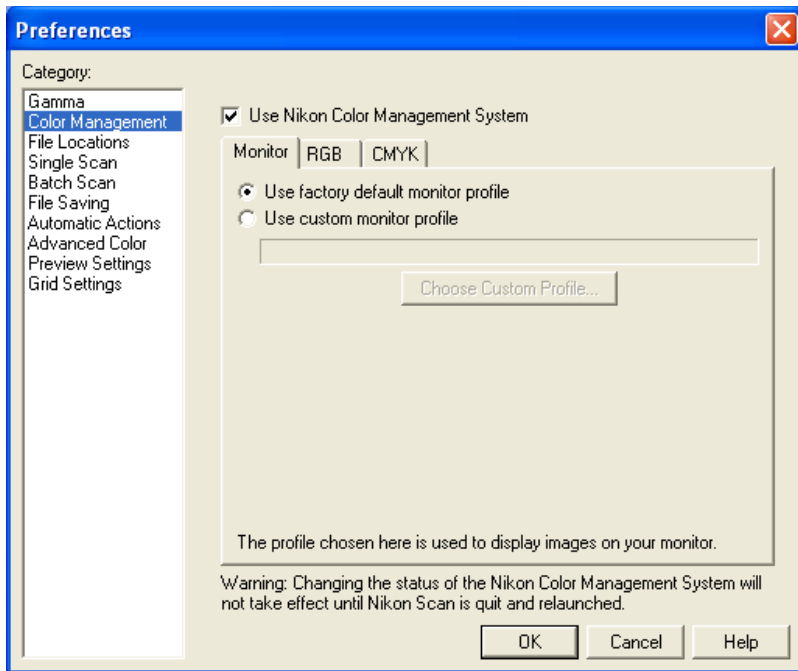
Use Nikon Color Management System

This option turns the Nikon Color Management System on and off. Changes to this setting only take effect after Nikon Scan has been quit and restarted.

When Nikon CMS Is On…

…images are processed to ensure consistent color reproduction, as described in "**How Nikon CMS Works" (79)**. Because color management profiles typically contain their own settings for gamma, the controls in the Gamma tab are dimmed and inactive.

When Nikon CMS Is Off…

…monitor and color-space profiles are not used, and the controls in the Color Management tab are dimmed and inactive. The only tool available for ensuring that colors from the scanner will be displayed accurately on the monitor is the **"Gamma" category (82)**. The only adjustments made to the image before it is passed to the host application are gamma adjustment and changes to curves and color balance made in the scan window.

The "Monitor" Tab

The "Monitor" tab specifies the profile that will be used when images are displayed on your monitor, either in the scan window preview area or a Nikon Scan image window. Monitor profiles contain information about the color and gamma characteristics of the monitor, allowing images to be adjusted for more accurate color reproduction.
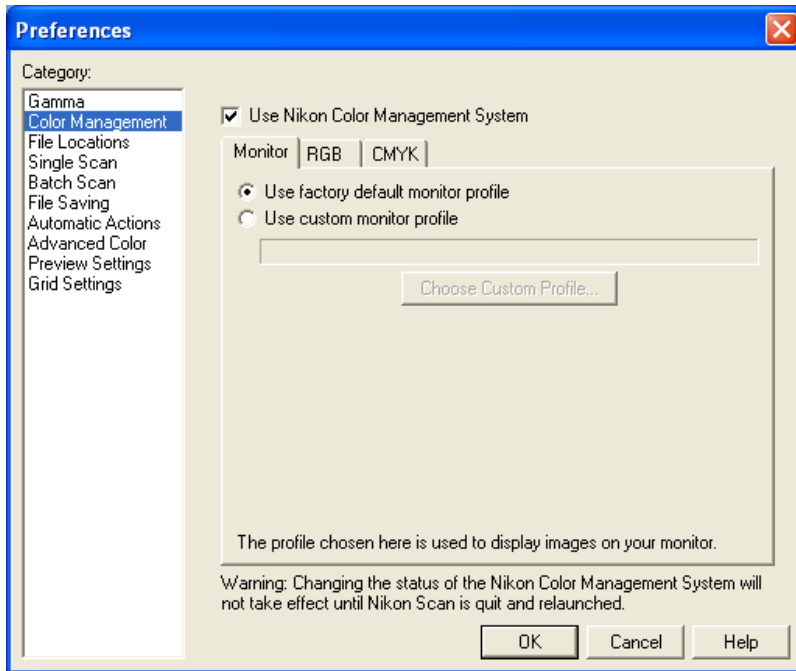
Use factory default monitor profile (default)

Nikon Scan is supplied with default monitor profiles for use when no other profile is available (see below). To use the default profile for your platform, select **Use factory default monitor profile**.

Default Windows Monitor Profile (Gamma 2.2)

The default Windows monitor profile ("NkMonitor_Win.icm") is identical to the sRGB profile.

Default Macintosh Monitor Profile (Gamma 1.8)

The default Macintosh monitor profile ("NkMonitor_Mac.icm") is identical to the profile used for Apple 17″ monitors with a D_{50} white point.

Use custom monitor profile

Use this option to select a profile supplied by the company that manufactured the monitor. When this option is selected, the **Choose Custom Profile…** button will be active. Clicking this button displays a standard "open file" dialog; navigate to the disk and folder containing the manufacturer's profile. The path to the selected profile will appear in the text box below the **Use custom monitor profile** radio button.

The "RGB" Tab

The "RGB" tab is used to select a color-space profile for the calibrated RGB color model. The profile used can be selected from the **Color space** menu.
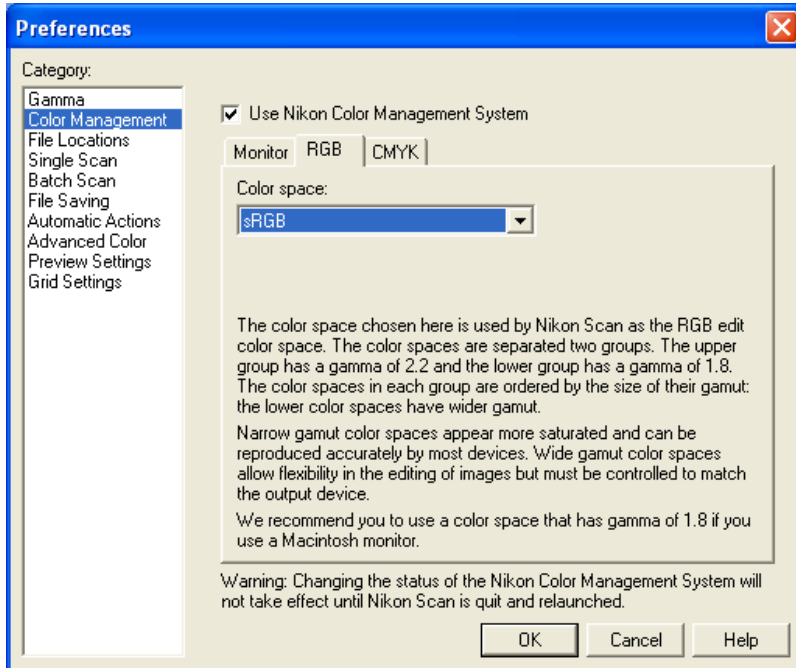

Each of the profiles listed may be classified according to its gamma value and gamut. *Gamma* is a fundamental characteristic of imaging systems which determines the intensity of the output signal relative to the input; in human terms, gamma controls the subjective brightness of images through alterations to the output level for mid-tones. Windows and Macintosh systems process video signals differently, and these differences are reflected in the difference in the standard gamma values for these platforms. The default system gamma for Macintosh computers is 1.8, the *de facto* standard for Windows systems, 2.2. Nikon CMS includes eight RGB profiles with a Windows gamma of 2.2 (sRGB, Bruce RGB, NTSC [1953], Adobe RGB [1988], CIE RGB, Wide Gamut RGB, compensated Wide Gamut RGB, and Scanner RGB), and three profiles with a gamma value of 1.8 (Apple RGB, ColorMatch RGB, and compensated Apple RGB), for use on the Macintosh. When scanning images, choose a profile with a gamma value suited to the system on which the image will be edited.

The "CMYK" Tab

The CMYK sheet is used to select a profile for use with the CMYK color model.
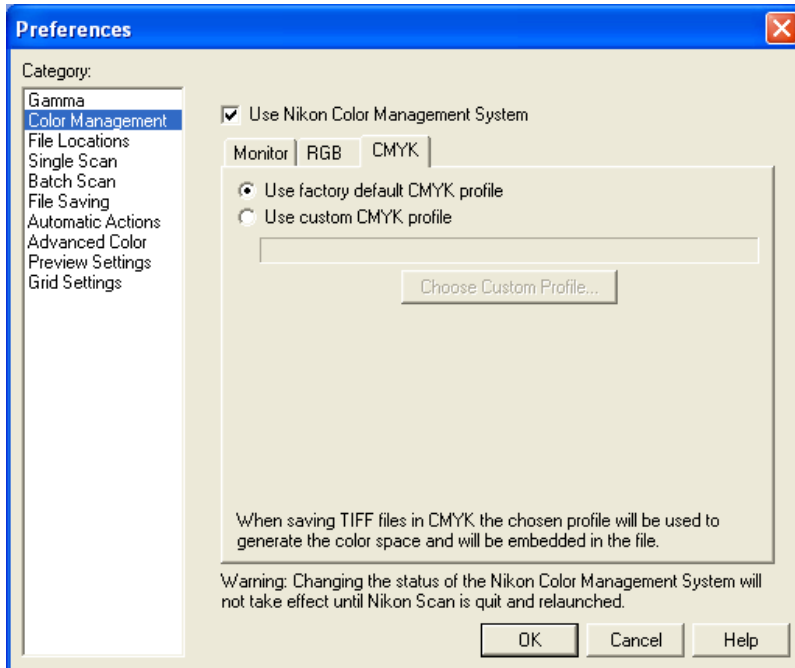
Use factory default CMYK profile (default)

Nikon Scan is supplied with a default CMYK profile (the SWOP color library) for use when no other profile is available. This profile is used when **Use factory default CMYK profile** is selected.

Use custom profile

Use this option to select a profile supplied by the company that manufactured your printer. When this option is selected, the **Choose Custom Profile…** button will be active. Clicking this button displays a standard open-file dialog; navigate to the disk and folder containing the manufacturer's profile. The path to the selected profile will appear in the text box below the **Use custom CMYK profile** radio button.

CMYK

Images can not be scanned in CMYK. If CMYK data are required, convert images to CMYK before saving them to disk. Note that images can only be saved in CMYK if Nikon CMS is on (Nikon CMS is on by default).

RGB Profiles Provided with Nikon Scan

Windows Profiles (Gamma 2.2)

sRGB

This RGB profile is used in the majority of Windows monitors. It closely resembles the RGB commonly used in color television, and is also used in the digital television broadcasting system that is on its way to becoming the industry standard in the United States of America. Software and hardware manufacturers use it as a default color profile and guarantee operation when it used. It is also on its way to becoming the standard for images on the web. This profile is suited to users who plan to use their digital images "as is," without editing or printing them. It however suffers from the drawback of a narrow gamut with a limited area available for reproducing blues. The corresponding RGB setting in Photoshop 5.0 is "sRGB."

Bruce RGB

This color profile attempts to expand on the ColorMatch RGB gamut by defining the chromaticity for G as lying between the values for G in the Adobe RGB and ColorMatch color-space profiles. It was proposed by Bruce Fraser, who claims that it includes most of the colors in the SWOP CMYK gamut. It is not provided in the standard install of Photoshop 5.0, but can be selected as the RGB color-space profile for Photoshop by importing the profile "NkBruce.icm".

NTSC (1953)

This is the color space for video defined by the National Television Standards Committee (NTSC) in 1953 and used in early color televisions. This color space is also used in some Far-East newspaper and printing organizations. The corresponding RGB setting in Photoshop 5.0 is "NTSC (1953)."

Adobe RGB (1988)

A color-space profile defined in Photoshop 5.0. It has a wider gamut than sRGB and includes the colors found in most CMYK gamuts, making it suitable for users involved in desktop publishing. The corresponding RGB setting in Photoshop 5.0 is "Adobe RGB (1988)."

CIE RGB

A video color-space profile established by the CIE. While it boasts a fairly wide gamut, it suffers from the drawback that the area devoted to the reproduction of cyan is relatively small. The corresponding RGB setting in Photoshop 5.0 is "CIE RGB."

Wide Gamut RGB

This color-space profile, designed by Adobe, incorporates most of the visible colors. This however has the consequence that most of the colors it can express can not be reproduced on standard monitors and printers. The corresponding RGB setting in Photoshop 5.0 is "Wide Gamut RGB."

Wide Gamut RGB (compensated)

Nikon scanners can scan some colors that cannot be expressed using the Wide Gamut RGB color-space profile. The compensated Wide Gamut RGB profile redefines Wide Gamut RGB to include all the colors that can be output from the scanner. Because many of the colors that can not be expressed in Wide Gamut RGB occur in the blue portion of the gamut, the level of detail in the blue area has been greatly increased (because the gamut has been expanded in a non-linear fashion to incorporate just those colors that could not otherwise be expressed, it can not be represented in chromaticity diagrams using a standard RGB triangle). As is the case with Wide Gamut RGB, most of the colors defined in this profile can not be reproduced on monitors and printers. It is output to the host application as Wide Gamut RGB. When scanning images into Photoshop 5.0 using this profile, set the Photoshop RGB profile to "Wide Gamut RGB."

Scanner RGB

This profile replicates the color space achieved when scanning with Nikon CMS off. Its main purpose is to allow the LCH editor and Unsharp Mask tools, which are not available when Nikon CMS is off, to be used to edit the colors produced by the scanner. In order to produce the effect achieved by turning Nikon CMS off, the monitor profile is not used, nor is an ICC profile included with the image when it is opened in the host application.

Macintosh Profiles (Gamma 1.8)

Apple RGB

This profile is used in desk-top publishing applications and in Adobe Photoshop versions 4.0 or earlier, and is the typical RGB profile for Macintosh monitors. The corresponding RGB setting in Photoshop 5.0 is "Apple RGB." This profile is suitable for working with images displayed on the Macintosh.

ColorMatch RGB

The ColorMatch profile is native to Radius PressView monitors. It has a wider gamut than Apple RGB, with a particularly wide area devoted to the reproduction of blues. The corresponding RGB setting in Photoshop 5.0 is "Color Match RGB."

Apple RGB (compensated)

This profile defines tristimulus (red, green, and blue) chromaticity as the intersection of the curve that marks the limits of the visible gamut with lines drawn from the Apple RGB white point and passing through the points that define tristimulus chromaticity in the Apple RGB color-space profile. This profile is unique in that it preserves the characteristics of Apple RGB while allowing more saturated colors. It is not provided in the standard install of Photoshop 5.0, but can be selected as the RGB color-space profile for Photoshop by importing the profile "NKApple_CPS.icm".
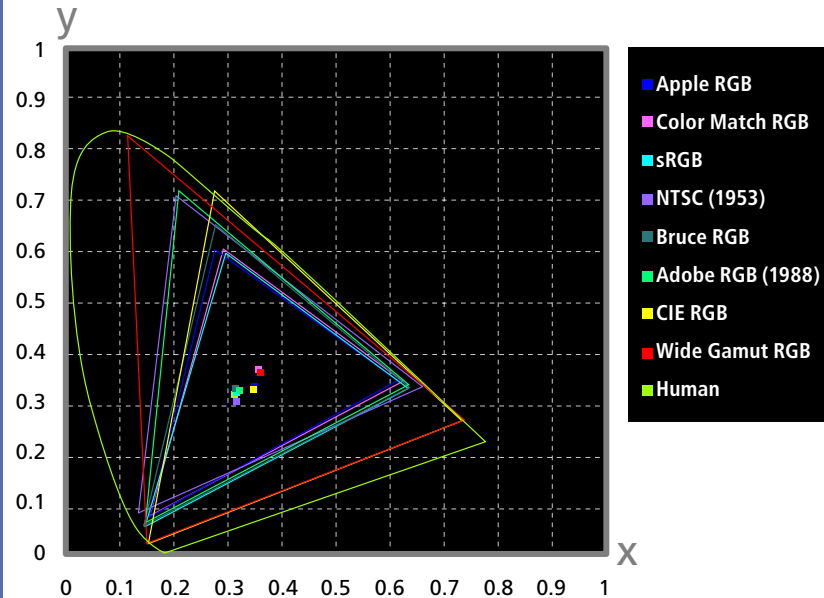
"Gamut"

In addition to gamma, profiles can be classified according to their *gamut*, or the range of colors that can be expressed using the profile. Gamut is conventionally expressed by means of *chromaticity*, a measure of color developed by the Commission Internationale de l'Éclairage (CIE). The CIE system, which is modeled on human color perception, maps the physical wavelengths of light to three coordinates (known as CIE X, Y, and Z) that give unique numerical expression to the full range of color differences that can be perceived by humans. Chromaticity is a measure of color from which considerations of brightness have been factored out, giving a two-coordinate system.

In the chromaticity diagram at right, the complete gamut of colors visible to humans is in the area enclosed by the green line. The curved portion of the line gives the chromaticity of "pure," unmixed colors with wavelengths in the visible spectrum of 380–780 nm. The blue end of the spectrum (380 nm) is at the bottom left corner, the red end of the spectrum (780 nm) at the bottom right corner. The straight diagonal line connecting these two points represents the different shades of purple created by combining red and blue light. The colors inside the area enclosed by these lines are created by mixing light of different wavelengths.

No color profile is capable of expressing the full range of colors visible to the human eye. The diagram below compares the gamut of colors visible to the eye with the colors that can be expressed in each of the RGB profiles provided with Nikon CMS. The gamut for each profile is contained in the triangle defined by the three points that mark the extremes of red, green, and blue for that profile (red is at the bottom right corner, green at the top of the triangle, and blue at the bottom left corner). The white point for each profile is shown by the symbol in the center of the triangle.

- ■ Apple RGB
- ■ Color Match RGB
- ■ sRGB
- ■ NTSC (1953)
- ■ Bruce RGB
- ■ Adobe RGB (1988)
- ■ CIE RGB
- ■ Wide Gamut RGB
- ■ Human

The following table shows the gamma values for the profiles included with Nikon CMS, together with the chromaticity values for the white point and for red, green, and blue.

Profile	White Point Name	White Point Value		Gamma Value	Chromaticity (x, y) Name	R		G		B	
sRGB	6500K (D$_{65}$)	x	0.3127159	2.2	HDTV (CCIR 709)	x	0.64	x	0.3	x	0.15
		y	0.3290015			y	0.33	y	0.6	y	0.06
NTSC (1953)	Std Illuminant C	x	0.3101	2.2	NTSC (1953)	x	0.67	x	0.21	x	0.14
		y	0.3162			y	0.33	y	0.71	y	0.08
Bruce RGB	6500K (D$_{65}$)	x	0.3127159	2.2	Bruce RGB	x	0.64	x	0.28	x	0.15
		y	0.3290015			y	0.33	y	0.65	y	0.06
Adobe RGB (1988)	6500K (D$_{65}$)	x	0.3127159	2.2	Adobe RGB (1988)	x	0.64	x	0.21	x	0.15
		y	0.3290015			y	0.33	y	0.71	y	0.06
CIE RGB	Std Illuminant E	x	0.3333333	2.2	CIE RGB	x	0.735	x	0.274	x	0.167
		y	0.3333333			y	0.265	y	0.717	y	0.009
Wide Gamut RGB	5000K (D$_{50}$)	x	0.3457029	2.2	700/525/450nm	x	0.7347	x	0.1152	x	0.1566
		y	0.3585386			y	0.2653	y	0.8264	y	0.0177
Apple RGB	6500K (D$_{65}$)	x	0.3127159	1.8	Trinitron	x	0.625	x	0.28	x	0.155
		y	0.3290015			y	0.34	y	0.595	y	0.07
ColorMatch RGB	5000K (D$_{50}$)	x	0.3457029	1.8	P22-EBU	x	0.63	x	0.295	x	0.155
		y	0.3585386			y	0.34	y	0.605	y	0.077
Apple RGB (Compensated)	6500K (D$_{65}$)	x	0.3127159	1.8	Custom	x	0.65	x	0.265	x	0.14
		y	0.3290015			y	0.341	y	0.717	y	0.0454
Default Windows Monitor	6500K (D$_{65}$)	x	0.3127159	2.2	HDTV (CCIR 709)	x	0.64	x	0.3	x	0.15
		y	0.3290015			y	0.33	y	0.6	y	0.06
Default Macintosh Monitor	5000K (D$_{50}$)	x	0.34570291	1.8	Trinitron	x	0.625	x	0.28	x	0.155
		y	0.3585386			y	0.34	y	0.595	y	0.07

Keeping Colors True in Other Applications

When an image is scanned in the Nikon Scan TWAIN source or acquire plug-in and opened in another application, or when an image saved using Nikon Scan is opened in another application, the image will be processed according to the color-space and monitor profiles selected in the application before being displayed on the monitor. If the profiles used in the application do not match those used in Nikon Scan, colors may not be the same as those in the original image.

RGB Color Model
Choose a monitor profile that matches that chosen in the "Monitor" tab and a color-space profile that matches that selected in the "RGB" tab (the Photoshop profiles corresponding to those used in Nikon Scan are listed on the preceding pages). If no matching RGB profile exists, you can use the Nikon Scan profiles in the path Program Files\Common Files\Nikon\Profiles (Windows) or System Folder : Preferences : Nikon MAID : Profiles (Macintosh). The files containing the profiles listed in the RGB sheet are given below.

Profile	File name
sRGB	NKsRGB.icm
Bruce RGB	NKBruce.icm
NTSC (1953)	NKNTSC.icm
Adobe RGB (1998)	NKAdobe.icm
CIE RGB	NKCIE.icm
Wide Gamut RGB	NKWide.icm
Apple RGB	NKApple.icm
Color Match RGB	NKMatch.icm
Apple RGB (compensated)	NKApple_CPS.icm

*Do not use the "Scanner RGB" profile when scanning images for use in a third-party application.

When Nikon Scan is used as an acquire plug-in to the Macintosh version of Adobe Photoshop 5 or later (full version), the RGB profile will automatically be passed to Photoshop when the image is scanned. Be sure that the monitor profile matches that used in Photoshop by selecting the Photoshop monitor profile in the monitor sheet of the Nikon Scan color management tab.

CMYK Color Model
Choose a monitor profile that matches that chosen in the monitor sheet and a color-space profile that matches that selected in the CMYK sheet. When Nikon Scan is used as an acquire plug-in to the Macintosh version of Adobe Photoshop 5 or later (full version), the CMYK profile will automatically be passed to Photoshop when the image is scanned.