

Image state adjustment in Adobe After Effects CS4 color workflows

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image state

An attribute of an image encoding indicating the rendering state of the image data. This usually refers to a part of the workflow. Examples of image state are scene images (*scene-referred*) and presentation viewing images (*output-referred*). Scene-referred images have not been rendered from the tone range and colors of the scene. Output-referred images are typically rendered for a particular device.

Introduction

Digital color values that travel through video or digital cinema workflows can be understood and interpreted in a variety of ways. A correct interpretation of color appearance can be achieved by using color management and assigning ICC color profiles to imported footage in After Effects. This assignment allows the correct color appearance to be translated into a common compositing color space (working space) defined for your After Effects project. The color management system (CMS) also allows for the correct display of colors from the project's working color space on your computer monitor as well as correct color output to a variety of different output conditions like high-definition TV, standard-definition TV, DPX values for film printing, or digital values appropriate for digital motion picture projection.

However, there are cases in which digital color values can be interpreted differently, depending on the part of the workflow those values refer to. The term *image state* is normally used to define this attribute of an image (see sidebar). You can see this ambiguity in values captured by a video camera. The gamma used to encode the video values captured by the camera may be one value (~1.9) whereas the gamma used to display those values may be another value (~2.2). (For this discussion, the complex encoding curves for Rec. 709 and sRGB have been approximated with a gamma value). Although surprising to many, this gamma difference is intentional, is prescribed by video standards, and allows for quality viewing of the video content. So, how are the characteristics of this video footage defined? Using the video camera encoding provides a correct interpretation of the video values in the workflow before it is rendered on the display. However, the visual appearance of the video values are best understood as they will appear on the final display. For various reasons, you may wish to work with your content using one or the other methods of defining the color appearance. However, you must make sure that the content is interpreted consistently when compositing in an application like After Effects.

Proper interpretation of values—the recorded scene or the presentation of the scene?

As mentioned above, there are differences in the contrast and gamma encoded by a video camera versus the contrast and gamma typical of an output device like a video monitor or motion picture projector. Should the digital values be decoded (interpreted) as they appeared in the scene (as recorded by the camera) or should they be decoded as they will be seen when output on a display device in a typical viewing environment?



Image 1a — Digital values interpreted using a color space which represents a typical high-definition television display (sRGB IEC 61299-2.1)



Image 1b — Digital values interpreted using a color space which represents a typical high-definition video camera (HDTV (Rec. 709))



HDTV (Rec. 709)

sRGB IEC61966-2.1

Image 2 — Grayscale interpreted using HDTV (Rec. 709) and sRGB IEC61966-2.1 ICC profiles

Images 1a & 1b show identical digital values decoded using gamma values from a high-definition (HD) display and gamma values from a high-definition video camera. Notice that image 1a is slightly darker with more contrast than image 1b. This is due to the gamma and contrast differences in the two profiles used to decode the digital values in the file. Image 2 shows this gamma difference using a gray gradient.

Adobe provides ICC profiles that decode commonly used video formats using camera gamma or display gamma. Table 1 shows these profiles. We can see from this table that the HDTV (Rec. 709) and sRGB profiles both decode high-definition video values.

Type of video	Profiles using camera gamma	Profiles using display gamma
high definition	HDTV (Rec. 709)	sRGB IEC 61966-2.1
standard definition (NTSC)	SDTV NTSC	SMPTE-C
standard definition (PAL)	SDTV PAL	PAL/SECAM

Table 1 — Camera and display profiles used for common video encodings

Why does this matter? When converting the colors of imported content into colors in the project’s working color space, we want to ensure that digital color values are interpreted the same way, either based on scene/camera colors or output/display colors. In order to ensure that there are no interpretation mismatches for footage/images, gamma of imported content will be adjusted to match the gamma of your project’s working space. The proper interpretation of the imported video footage/images is based on the relationships in Table 1. In the case of an HD video workflow (which uses the HDTV (Rec. 709) profile as the working space), imported sRGB content is understood using the HDTV (Rec. 709) gamma to prevent the gamma mismatch between imported footage and the working space. In this way, HD video values are maintained. If gamma adjustment is not made, sRGB color values will darken when converted to the HDTV (Rec. 709) working space for compositing and will not match original HD values captured by the camera. When compared to original HD camera values, these converted sRGB values will also look relatively dark when viewed on an HD display.

Also note that imported images that use encodings associated with display devices, like Adobe RGB (1998) or Apple RGB, will also undergo gamma adjustment when converted into a scene-referred working space like HDTV (Rec. 709) or SDTV NTSC. This gamma adjustment is made after colors are converted to preserve color appearance. In the example of Adobe RGB (1998)

colors imported into a project with an HDTV (Rec. 709) working space, the following color conversions take place:

- 1) Adobe RGB (1998) colors are converted to HDTV (Rec. 709) colors.
- 2) A gamma adjustment is applied to these HDTV (Rec. 709) colors. The gamma adjustment changes the image state of the imported footage to match the image state of the project working space.

Tables 2 and 3 provide a list of commonly used profiles and the type of gamma encoding used for each.

ICC profiles for scene (camera)
HDTV (Rec. 709)
SDTV NTSC
SDTV PAL
Universal Camera Film Printing Density
Kodak 5218/7218 Printing Densities (by Adobe) and other ICC profiles based on camera negative film
ARRIFLEX D-20 Daylight Log (by Adobe) and other ICC profiles based on digital camera capture

Table 2 — Commonly used scene-referred profiles

ICC profiles for presentation (display)
Adobe RGB (1998)
Apple RGB
PAL/SECAM
ProPhoto RGB
SMPTE-C
sRGB IEC61966-2.1

Table 3 — Commonly used output-referred profiles

Non-video workflows may also require gamma adjustments to prevent camera/display gamma mismatches. The “Workflows” section below provides examples for the digital cinema and Flash workflows as well as the video workflow.

Workflows

After Effects video and digital cinema workflows

When using color management in video and digital cinema workflows in After Effects, designers typically use scene-referred color spaces to interpret footage. The same scene-referred color spaces are also used as project working spaces for compositing. (HDTV (Rec. 709) is typically used for HD video, and Universal Camera Film Printing Density is used for cinema. See the *Color Management workflow in Adobe After Effects CS4* white paper for details on these workflows.)

But what happens when content is imported into a video or cinema project and interpreted using an output-referred ICC profile like sRGB IEC 61966-2.1 or Adobe RGB (1998)? In this case, 1) the imported content is converted to HDTV (Rec. 709) colors and 2) a gamma adjustment is applied to eliminate the image-state mismatch between the imported content and the project working space. This gamma adjustment step is done automatically for new projects created using After Effects CS4. Projects created with earlier versions of After Effects will not have this gamma adjustment feature active; this preserves the appearance of these legacy projects. Auto-adjustment of gamma can be controlled using the Compensate For Scene-referred Profiles option in the After Effects CS4 Project Settings dialog box.

After Effects Flash workflow

When using color management in a Flash workflow in After Effects, designers typically use embedded profiles like sRGB IEC61966-2.1 or Adobe RGB (1998) to interpret image colors of imported content. These profiles decode values in an image file to color appearance in viewing environments (output-referred). The sRGB IEC61966-2.1 color space is typically used as a project working space, as well as an output color space when rendering and exporting to Flash formats. (See the *Color Management Workflow in Adobe After Effects CS4* white paper for details on this workflow.) Since profiles used in this example are all based on how colors look in a viewing environment, there is no need for an automatic gamma adjustment.

However, what happens when video content has been interpreted using a scene-referred profile like HDTV (Rec. 709) and imported into an After Effects project which uses the output-referred

sRGB IEC 61966-2.1 profile as the project working space? In this case, 1) a gamma adjustment is made to the imported content to change the image state from scene-referred to output-referred and 2) colors are converted to the project working space. This gamma adjustment, in step 1, is done automatically for new projects created using After Effects CS4. Projects created with earlier versions of After Effects will not have this gamma adjustment feature active; this preserves the appearance of these legacy projects. Auto-adjustment of gamma can be controlled using the Compensate For Scene-referred Profiles option in the After Effects CS4 Project Settings dialog box.

Additional resources

Charles Poynton's Gamma FAQ

<http://www.poynton.com/GammaFAQ.html>

International Color Consortium white papers

<http://www.color.org/whitepapers.xalter>

ITU Recommendation 709 specification

<http://www.itu.int/rec/R-REC-BT.709-5-200204-I/en>

Adobe After Effects user-to-user forum

<http://www.adobeforums.com/cgi-bin/webx/.ee6b2fe/>

Color Management Workflow in Adobe After Effects CS4 white paper

http://www.adobe.com/go/learn_ae_colormanagementpaper

For a complete list of color profiles available for After Effects CS4, see the “Profiles” appendix in the *Color Management in Adobe After Effects CS4* white paper.