

Color rendering—for print or screen display—is one part precise, one part interpretive. As for “accuracy,” it all depends on a number of variables.

Color theory, color reality

Digital cameras “see” and record images far differently than our eyes do. I’ve discussed how digital camera captures are essentially files of RAW grayscale data. However, you can opt to convert that RAW file into a color space such as Adobe RGB (1998) or sRGB, in your camera system through a process called *rendering*.

Ideally, the rendering process makes the RAW data look the way you want it to, then encodes that data into an RGB color space.

The scale of color, luminance and saturation in any real-world scene is likely to range far beyond the capture capabilities of your digital camera, and certainly beyond the reproduction capability of any output device. In most cases, rendering done for *scene colorimetry*—the attempt to make the image match the *measured color* of the actual scene—will not yield pleasing results on a

display. Color geeks also refer to scene colorimetry as *input-* or *scene-referred*.

To get pleasing color that represents the scene, we need to apply *output-referred* rendering to fit the color gamut and dynamic range of the scene-referred data to the capabilities of the output device.

You can set most digital cameras to render on the fly with a color matrix setting such as sRGB or Adobe RGB (1998), but that gives you no control over the rendering process. By capturing RAW data, you can control the rendering to produce the results you want in a RAW converter software like Adobe Camera Raw.

Each RAW converter might have its own default setting for rendering, but there are controls available for setting your own rendering parameters, and even for programming your own custom default settings.

To create an output-referred image, the camera or computer system has to perform the color rendering process first, and then encode the resulting color data into a color space such as sRGB. The data rendering is based on each camera manufacturer’s specs for producing the most pleasing image appearance from the RAW data, and there is no standardization. In-camera rendering varies with each manufacturer, and perhaps even among models from the same manufacturer.

Because sRGB is rendered to output-referred data, it cannot be used to accurately represent the scene, or what some



The darker image above was shot in linear mode with no processing to render it to output referred. The image at top is output referred for ColorMatch RGB, which is based on the behavior of a calibrated CRT display.

would call the colorimetry (measured color) of the scene. This isn’t necessarily a problem for most users. With film stock, color bias (how it *rendered* color) has always varied among different types and manufacturers, and photographers would choose film types based on that bias. Two sRGB encodings of the same scene from different makes of camera won’t be identical matches, in the same way that two perceptual rendering intents from two different ICC profiles created by two different profile packages will not be identical. This is one reason why many cameras have several sRGB settings for in-camera rendering. As with film, each has a slightly different color bias.

The actual data encoding is standardized and unambiguous. Two identical renderings of the same scene will produce identical encodings in, for example, sRGB.

Most photographers prefer to have control over the process, so for them capturing RAW data and using a good RAW converter to perform the rendering is the best way to handle it.

Think of it this way: if you produce an sRGB image file, it won't be a colorimetric copy of the scene you photographed, but an image of the scene as it would look rendered to an sRGB display or correctly previewed in an ICC-aware application like Adobe Photoshop.

The sRGB image describes the picture on an sRGB display. The display should behave, more or less, as described by the specifications that define sRGB, which is derived from a HDTV standard display of a specific phosphor set/gamma/luminance and ambient condition. Of course, if the display is profiled and the data being previewed has an embedded profile, the sRGB file or any tagged file for that matter, will preview correctly in an application like Photoshop.

Nevertheless, what you see, and ultimately output, isn't a colorimetric representation of the actual scene. This is one reason why producing "accurate" color from a digital camera can be difficult. I put accurate in quotes because nearly every user has his or her own perception of "accurate."

This also is a reason why building good ICC profiles for digital cameras is difficult; you are actually profiling the rendering of the data, not the colorimetric (scene-referred) data. If you set your digital camera to produce this rendering on the fly, then the color management portion of dealing with the input data is being handled by the camera.

Most photographers prefer to have control over the process, so for them capturing RAW data and using a good RAW converter to handle the rendering is the best way to handle it. The decision is yours, but it's useful to understand the trade offs for each option. ■