White Balance

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Color Balance is the term used in the film world to indicate that the color temperature of the light source matches the expected color temp for which the film's spectral response is optimized. Since there are currently only two types of film (Daylight Balanced and Tungsten Balanced)[1] that means that the use of "CC" (Color Correction) filters was mandated to balance light and film. Mercifully those days are behind us in the digital world.

In the digital world we use the term "White Balance" which is a carry over from the video world.[2] It is so much easier for us but it has led to some major misconceptions where technically accurate data, taken out of context, has proved to be misleading to photographers and photo students. To put the context back as well as to make sense of the instructions for doing a correct white balance, we need to examine the two major issues that collide here.

1. Digital Camera White Balance settings and options
2. RAW file format capture

Then we can get to the instructions on doing it right so you can maximize the quality of your video capture files.

Digital White Balance Settings

Digital Cameras have made the issue of color balancing very easy. Although each chip type does have its own specific spectral response, they are close

[1] There used to be a "Type A" color film balanced for 3800°K that worked with specific flash bulbs but it has long been discontinued.

[2] Video cameras are both White Balanced for color and signal levels to set the white point. They were also then Black Balanced to set the pedestal or black levels.

enough that general balancing settings can be programmed into them to tell them how to interpret incoming data to achieve relative color neutrality, i.e. make the expectations of the medium, in this case a chip, more or less match the light source's color temperature.

It is imperfect but generally close enough that it requires little more than some judicious tweaking in the post production phase to make it appear correct. Assuming, that is, that the actual color source of the light matches the expectations of the various "filters." These are not really filters in the normal sense but are pre-set variables to the interpolated RGB signals that mimic the effect of having actual filters over the lens. That it works *at all* is pretty amazing but that it works as well as it does is even more so.

The settings are based on what photographers refer to as "Color Temperature." This is measured on the Kelvin[3] Thermodynamic Scale in which "0" (Zero) is "Absolute Zero."[4] It is only coincidentally related to temperature as we normally use the term but we'll ignore that for the moment. Too many photo textbooks have cemented the terminology in our media to overturn it with something as banal as accuracy.

To determine a light source's Color "temperature," a "Black Body Radiator" that absorbs all of the light which strikes it (or in the vernacular of us non-scientific types, a closed container lined with pure graphite, with a small hole through which the radiation of light, if any, is observed) is heated in a kiln. As it heats up the material begins to emit light. That emitted light changes color, just like steel or other minerals. It gradually goes from red at about 1,000K[5] to yellow to white and then, before it vaporizes, to blue. Its color is measured at different K increments or "Kelvins" and that color becomes it's "Color Temperature."

For photography, as well as videography and cinematography, specific Kelvins are used as standards for both the color temp of light sources and the settings for the medium whether film or video or a digital imaging chip. When those are the same for the source and the medium's setting they are said to be in balance or, as we photo types say, "color balanced."

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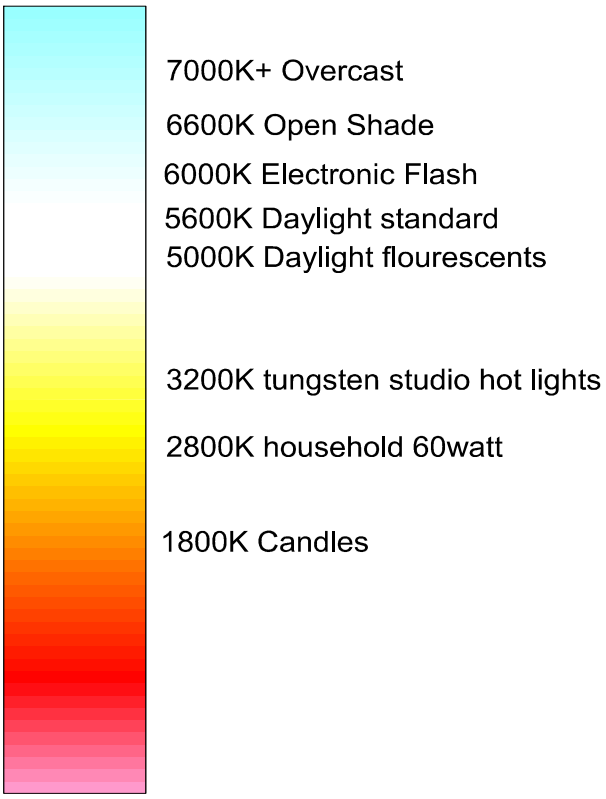
[3] Named after William Thomas, 1st Baron Kelvin (1824-1907)

[4] Absolute Zero is the theoretical state of 0 entropy, meaning the absence of all thermal energy. It is -459.67° on the Fahrenheit scale and -275.15° on the Celsius scale. Properly speaking it is not a "degree" of temperature and therefore is properly written without the degree symbol. So it should be written as 5600K and ***NOT*** 5600°K

[5] OK, for you anal types, it is 798K to be exact which is the "Draper Point" at which ALL solid bodies begin to glow a dim red color.

Here are some of the standard Kelvins we use in Photography. Yes, I know, photographers generally have no idea what a "Kelvin" is so we will tend to use, when talking about a color source, the more common but technically incorrect term, "Color Temperature.



Unlike film with only its two levels of Kelvin expectations (daylight and tungsten), in digital we can set most DSLRs to several including Daylight, Tungsten, Flash, Shade, Overcast, etc. So it looks like we have the entire problem solved. Too bad that looks can be so deceiving.

The problem is that there are a huge number of real world variables that can affect the color temperature of a light source. Atmospheric particles and angle/declination of the sun change its temperature (sunsets are normally around 2500K to 3000K). Discolored diffusers, soft boxes, and umbrellas change the color in the studio along with the degradation of color due to long use of the bulb or uneven power to the instrument. In landscapes, light filtered by leaves or reflected from rocks, water, grass, or other scene elements can be color-influenced enough that the specific setting of the camera is no longer rendering accurate color because it is not in precise color balance.

Nevertheless, there are some authors and would-be gurus who insist that it does not matter because if you are shooting RAW, the data is unprocessed for color balance anyway and you can correct it in the RAW converter.

This is a case of being technically correct but factually misleading by removing some elements from their context. To explain that, let's look at Camera RAW from the perspective of color balance.

THE RAW FILE FORMAT

RAW is not so much a format as a type. TIFF and JPEG files are a format. But RAW simply refers to a largely unprocessed file. Different manufactures each have their own proprietary RAW format, such as Nikon's NEF or Canon's CR2 but they all share a common approach to data.

In a RAW file, the instructions from your camera's menu settings are all stored in a header file that is part of the complete data. Mechanical settings like focus, aperture and shutter speed, and their effect on depth of field and motion, are unchangeable after the shot is taken[6]. But menu-based directions telling the computer how to process the image are things that can be changed in Raw since they have not yet been processed into the file. Contrast, sharpness, saturation, and white balance are all directions that ask the processor to alter the appearance of the processed image and those can be changed in the post production process.

The Raw converter will render a version of your file based on the settings you have specified. It will normally zero-out or null the settings as far as the adjusting sliders are concerned and now you are free to start "correcting" things.

And sure enough, there in the panels of most RAW converters is a section where you can change the White Balance settings from "As Shot" (which is however you had your camera set) to some specific setting matching those options on your camera's menu (Daylight, Tungsten, Shade, etc.)

It sounds like a dream come true. There are people who will even assert you can simply forget paying attention to such things and then fix it in the edit stage. If your goal is the maximum quality output then those are dangerous assertions. And if you hear that from someone you should immediately start to question everything else they are telling you because accuracy is only coincidental.

[6] The Focus issue, along with Depth of Field is being addressed with new technology from MIT and Stanford which will allow for alterations in focus and depth of field in post production. The technology exists but making it economically practical is another story. (http://graphics.stanford.edu/papers/lfcamera/)

If only it were true… Let's make this simple and keep the view strictly on white balance since that is our topic *du jour*.

If, in fact, your scene was TRULY daylight balanced but you had the camera set on, say, Tungsten, then yes, you could simply tell the RAW converter to change that to Daylight and all would be well… assuming, that is, you had color calibrated for your specific chip's color anomalies, which of course you have done. Right?

But if, for example, the scene were influenced by the sunlight reflecting off of the green meadow, bouncing onto the grey rock and it was THAT reflected greenish light that was creating most of the light on your scene, you have a problem. The Kelvin scale does not include green since it is not a color phase through which the Black Body Radiator passes on its heated march from red to blue. The specific menu settings and the adjustment settings in the RAW converter are helpless to deal with that. And even if the actual color was somewhere on the Kelvin scale but not at one of the standard settings, you have no way to deal with that unless you actually knew what the real color temp was. You can use the "tint" and "hue" sliders to make it perceptually better and correct for chip variances, but is that truly accurate and neutral? And how would you ever know?

Are you beginning to see the problem with this claim of an easy fix?

Fortunately there IS a relatively easy fix and it would have started back at the shooting/capture phase. And it has the benefit of being able to handle nearly ANY color influence from the light source, whether outdoors or in the studio.

CREATING A GOOD COLOR BALANCE

Creating a good color balance starts from the very first, actually a little before the first. It begins with your creating a custom color balance based specifically on the scene where you are shooting and, more precisely, the color temperature of the light source at that scene. Creating a custom white balance is easy even though the procedure varies a little between brands.

You will need to read your manuals to see precisely what procedure your camera requires. Some (e.g. Nikon) simply have you point at the neutral target and pres the shutter release at which point it will calculate a custom balance without

actually taking the shot. Others (e.g. Canon) have you take a frame of the target and then when you custom balance it will evaluate that frame. But in common with all of them is the need to aim at or shoot a frame of a target that is truly a neutral color.

Because it is called "White Balance" a lot of people think it needs to be done with a white target card. The video world uses white because that is setting the "Video" or acceptable highlight level as well as color balancing. In the still world, we are simply setting for color. That means we can use a gray card as well. Although an 18% gray card is a common target, the real issue is not the reflectance value but its chromatic neutrality.

Many so-called gray cards used in still photography have the proper reflectivity to be used to set exposure levels but are not good targets for white balancing because they are not truly neutral. This has become a sufficiently big deal in the digital arena that cards with real neutrality advertise that on the packaging and often show the spectral response curves to prove it.

White — that is, a truly neutral white — works fine. But white is a tone that is hard to judge for neutrality. But most people can easily detect slight amounts of color saturation in mid tones so the color cast of gray cards is generally easy to spot and therefore the gray card is often preferred to a white one for setting white balance.

Kodak's card is inexpensive and works but it is a special paint on cardboard. It is UV sensitive and will fade if left in the sun. When it gets dirty and is no longer neutral it cannot be easily cleaned without having an effect on its color.

Several companies make white balancing cards out of extruded plastic. They are not only neutral but because the color in throughout the material, can be cleaned easily. Most are actually lighter than the 18% gray card and so cannot be used for exposure calibration but are good for white balancing. Some (WhiBal)[7] even come with black and white target patches to help you set the levels for white and black points if you include one in your master shot.

But in addition to target cards there are a number of other devices on the market that can be used to set a white balance. Some are other target devices you aim the camera at, others are like filters or incident integrating domes. These filter style devices work in the same way the integrating domes worked on the old hand-held color meters. They integrate the incoming light to produce median color cast and then the camera uses its white balancing function to tell the interpolation routine how to neutralize it (or the RAW file how to display it).

[7] http://www.rawworkflow.com/whibal/

One of the better known is the "ExpoDisk." It can be held over the lens or screwed on like a filter.[8] In this case, instead of aiming at the neutral card, you place the filters over the lens and aim it at the light source, then take the frame.

This works well when you have a clear view of the light source although it is slightly inconvenient in a studio when you have to dismount the camera from a tripod or camera stand and aim it back at a light.

A new entry about to be released from Color Right[9] (who makes color balance filters in various shades to, as the videographers say, "cheat the balance" to emphasize warm or cool tones) called the "Color Cheetah" is more like an incident dome and according to preliminary data can be aimed at the subject which will make them far easier to use.

If used correctly any of these devices ranging from the inexpensive Kodak 18% Gray Card to some of the pricier filter-like devices can all get you very close to a true neutral color rendering resulting in accurate color. And all of them are better than relying on the set color balance "filters" of the camera menu. Even when off a little, the results of a properly done custom balance are so close that if you also put a neutral gray target in the scene, it is now easy to use the Converter's or Photoshop's white balance function to finish the job.

To maintain the optimum color, even outdoors, remember the light is always changing. Clouds cool it down dramatically: as the day progresses from dawn to noon to sunset the color of the light is changing all of the time. So continue to make new custom color balance adjustments throughout the day or as the conditions change around you. If you move to a spot where you are getting light being reflected from a building or rock face or car or anything that can influence the color, take a new custom balance.

CONCLUSIONS

So what difference does it all make anyway? How necessary is accurate color? Film color is not accurate and for the same reasons we have noted above for lack of flexibility in matching the color temperature of the light sources plus the addition of varying saturation. It is well known that some film favors cool colors

[8] http://www.expoimaging.net/product-overview.php?cat_id=1&keywords=ExpoDisc
[9] http://www.colorright.com/products

wile another favors warm tones. So if the great film world is off why worry about it in digital?

For most amateur photographers, the truth is, is does not matter. Neither they nor the people who see their work can tell the difference anyway. So why bother?

Well, let's assume you actually do care about the quality of your images. That is why you are in school or reading this datasheet. The reason to bother with this is that you cannot make a perfect print, even if the goal is a modified color scheme, without a perfect capture file.

If you are a pro (or want to be one) then there are times when dead-on accurate color is an essential requirement for the job. Products manufacturers are very narrow minded about photos in which the color they spend megabucks designing into the product is not portrayed accurately. Portrait clients tend to be averse to images of themselves with a strange color cast. And even landscape shots just come alive when the colors are accurately captured in the first place.

So pro shooters went to long lengths to test and then filter their film to give them accurate color when needed; and it was always a sort of craps shoot. But in digital we can get it correct or nearly so right out of the camera. Just as the histogram now lets us evaluate exposure and contrast on the spot in ways film shooters would die for, we can also adjust color balance on the spot to get us as close as possible to an accurate color rendition. You can always play with the colors in Photoshop and to a nearly infinite degree. But to get from off color back to accurate and neutral is often frustratingly impossible. You can get closer to be sure. But accuracy is another issue.

So it is up to you and is ultimately wrapped up in a single, simple question. How important is it to you to consistently make photographs of maximum quality?

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