White Balance

White balance

What is Colour Temperature? First the technical bit.

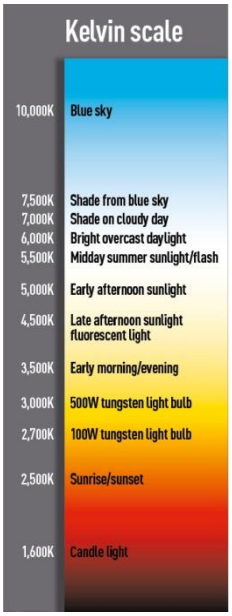
Light is not always what it seems. Our eyes are very forgiving, so when we move from place to place everything seems normal in terms of colour. So, for example, when moving from a bright daylight environment to a room lit by a candle all that will appear to change, to the naked eye, is the light level. Yet record these two situations using colour film and the first will have a blue hue and the latter will come out with a heavy orange cast. This is because our brain can quickly adjust to the changes, making white appear white, whereas film is balanced for one particular colour and anything that deviates from this will produce a colour cast.

The colour variation is referred to as the colour temperature and is measured in degrees Kelvin. The scale ranges from the flame of a candle at around 1900K to deep blue sky at around 10,000k as illustrated by the diagram below.

The light source is listed next to the degrees in Kelvin, both set against the colour of the light at each level.

You will notice that the colour next to the Average noon daylight (5500K) is white. This is the colour temperature that colour film is balanced to which means that when shooting using daylight film the photograph will record white objects as white and all the colours in an image will appear natural on the film. If you shoot in conditions that measure a higher temperature the photo will start to become bluer and shoot in conditions below the 5500 temperature and they will increase in orange.

The colours here don't just relate to daylight conditions artificial light also introduces a colour cast. With fluorescent lights this is often green and with tungsten lighting it will be yellow, while flash can be slightly blue.



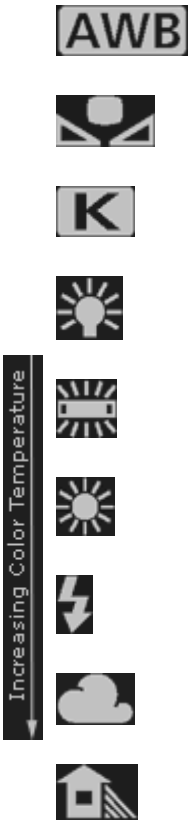
What is white balance

White balance (WB) is the process of removing unrealistic colour casts, so that objects which appear white in person are rendered white in your photo. Proper camera white balance has to take into account the "colour temperature" of a light source, which refers to the relative warmth or coolness of white light. Our eyes are very good at judging what is white under different light sources, but digital cameras often have great difficulty with auto white balance (AWB) — and can create unsightly blue, orange, or even green colour casts. Understanding digital white balance can help you avoid these colour casts, thereby improving your photos under a wider range of lighting conditions.

Camera Settings

Fortunately, most digital cameras contain a variety of preset white balances, so you do not

have to deal with colour temperature and green-magenta shift during the critical shot. Commonly used symbols for each of these are listed below.



The first three white balances allow for a range of colour temperatures. Auto white balance is available in all digital cameras and uses a best guess algorithm within a limited range — usually between 3000/4000 K and 7000 K. Custom white balance allows you to take a picture of a known gray reference under the same lighting, and then set that as the white balance for future photos. With "Kelvin" you can set the colour temperature over a broad range.

The remaining six white balances are listed in order of increasing colour temperature; however many compact cameras do not include a shade white balance. Some cameras also include a "Fluorescent H" setting, which is designed to work in newer daylight-calibrated fluorescents.

The description and symbol for the above white balances are just rough estimates for the actual lighting they work best under. In fact, cloudy could be used in place of daylight depending on the time of day, elevation, or degree of haziness. In general, if your image appears too cool on your LCD screen preview (regardless of the setting), you can quickly increase the colour temperature by selecting a symbol further down on the list above. If the image is still too cool (or warm if going the other direction), you can resort to manually entering a temperature in the Kelvin setting.

If all else fails and the image still does not have the correct WB after inspecting it on a computer afterwards, you can adjust the colour balance to remove additional colour casts. Alternatively, one could click on a colourless reference (see section on neutral references) with the "set gray point" dropper while using the "levels" tool in Photoshop.

By far the best white balance solution is to photograph using the RAW file format (if your camera supports them), as these allow you to set the WB *after* the photo has been taken. RAW files also allow one to set the WB based on a broader range of colour temperature and green-magenta shifts.

Performing a white balance with a raw file is quick and easy. You can either adjust the temperature and green-magenta sliders until colour casts are removed, or you can simply click on a neutral reference within the image (see next section). Even if only one of your photos contains a neutral reference, you can click on it and then use the resulting WB settings for the remainder of your photos (assuming the same lighting).

A neutral reference is often used for colour-critical projects or for situations where one anticipates auto white balance will encounter problems. Neutral references can either be

parts of your scene (if you're lucky), or can be a portable item which you carry with you.

On the other hand, pre-made portable references are almost always more accurate since one can easily be tricked into thinking an object is neutral when it is not. Portable references can be expensive and specifically designed for photography, or may include less expensive household items. An ideal grey reference is one which reflects all colours in the spectrum equally, and can consistently do so under a broad range of colour temperatures. An example of a pre-made grey reference is shown below:

Common household neutral references includes the underside of a lid container. This is both inexpensive and reasonably accurate, although custom-made photographic references are the best (such as the cards shown above). Custom-made devices can be used to measure either the incident or reflected colour temperature of the illuminant. Most neutral references measure reflected light, whereas a device such as a white balance meter or an "ExpoDisc" can measure incident light (and can theoretically be more accurate).

Notes On Auto White Balance

Certain subjects create problems for a digital camera's auto white balance — even under normal daylight conditions. One example is if the image already has an overabundance of warmth or coolness due to unique subject matter. The image below illustrates a situation where the subject is predominantly red, and so the camera mistakes this for a colour cast induced by a warm light source. The camera then tries to compensate for this so that the average colour of the image is closer to neutral, but in doing so it unknowingly creates a bluish colour cast on the stones. Some digital cameras are more susceptible to this than others.

Automatic White Balance

Custom White Balance (Custom white balance uses an 18% gray card as a neutral reference.)

A digital camera's auto white balance is often more effective when the photo contains at least one white or bright colourless element. Of course, do not try to change your composition to include a colourless object, but just be aware that its absence may cause problems with the auto white balance.

In Mixed Lighting

Multiple illuminants with different colour temperatures can further complicate performing a white balance. Some lighting situations may not even have a truly "correct" white balance, and will depend upon where colour accuracy is most important.

Under mixed lighting, auto white balance usually calculates an average colour temperature for the entire scene, and then uses this as the white balance. This approach is usually acceptable; however auto white balance tends to exaggerate the difference in colour temperature for each light source, as compared with what we perceive with our eyes.

Exaggerated differences in colour temperature are often most apparent with mixed indoor and natural lighting. Critical images may even require a different white balance for each lighting region. On the other hand, some may prefer to leave the colour temperatures as is.

Note how the building above is quite warm, whereas the sky is somewhat cool. This is because the white balance was set based on the moonlight — bringing out the warm colour temperature of the artificial lighting below. White balancing based on the natural light often yields a more realistic photograph. Choose "stone" as the white balance reference and see how the sky becomes unrealistically blue.

Custom White Balance

While you could let your camera's Auto White Balance determine the WB, cameras are, as a rule, not smart and can produce some weird results in mixed lights. The above image is lit by both indirect daylight from a nearby window and an incandescent bulb.

Suppose you took several photos at an event hall where they often mix orange and green florescent and halogen lights. How long would it take for you to go through all the images in an image editor to correct the WB? You could avoid this post-processing step by taking 30 seconds to do a test shot with an 18% gray card.

Step 1. Check your manual and see if you have the option to set a custom WB. (If your camera doesn't, skip ahead to the next section.) Read up on how to find it in your camera's menu and how to set it.

Step 2. Get your lights set up if you're using artificial ones like Strobes, flashes, etc.

Step 3. Find the option for custom WB. Refer to your manual if you're not sure where it is.

Step 4. Hold your 18% gray card out in front of the camera, and make sure all the lights you're using fall on it, and hit the shutter button for your test shot. You may need to try a few times to get a good position if your card is small.

Step 5. Get back behind the camera and check the display. You may need to move the 'box' into the position. Your manual should have instructions on how.

Step 6. Proceed to shoot without the gray card. Keep in mind that if you change your light position, power level, add or subtract a light, it may be necessary to set a new custom WB.

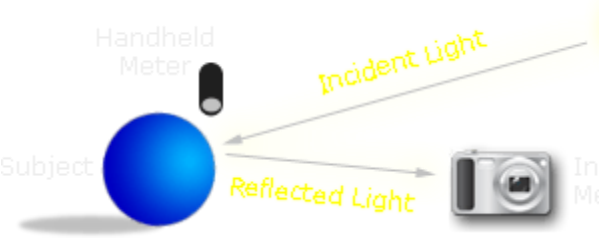
That's it. You've just saved yourself a step in your post-processing workflow. And your WB should be much improved, if not perfect.

Exposure METERING

Knowing how your digital camera meters light is critical for achieving consistent and accurate exposures. Metering is the brains behind how your camera determines the shutter speed and aperture, based on lighting conditions and ISO speed. Metering options often include partial, evaluative zone or matrix, centre-weighted and spot metering. Each of these have subject lighting conditions for which they excel — and for which they fail. Understanding these can improve one's photographic intuition for how a camera measures light.

Background: Incident Vs. Reflected Light

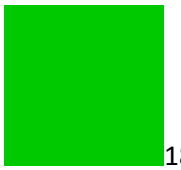
All in-camera light meters have a fundamental flaw: they can only measure reflected light. This means the best they can do is guess how much light is actually hitting the subject.



If all objects reflected the same percentage of incident light, this would work just fine, however real-world subjects vary greatly in their reflectance. For this reason, in-camera metering is standardized based on the luminance of light which would be reflected from an object appearing as middle gray. If the camera is aimed directly at any object lighter or darker than middle gray, the camera's light meter will incorrectly calculate under or over-exposure, respectively. A hand-held light meter would calculate the same exposure for any object under the same incident lighting.


18% Gray Tone


18% Red Tone


18% Green Tone


18% Blue Tone

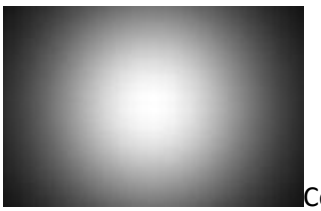
Above patches depict approximations of 18% luminance. This will appear most accurate when using a PC display which closely mimics the sRGB color space, and have calibrated your monitor accordingly. Monitors transmit as opposed to reflect light, so this is also a fundamental limitation.

What constitutes middle gray? In the printing industry it is standardized as the ink density which reflects 18% of incident light, however cameras seldom adhere to this. This topic deserves a discussion of its own, but for the purposes of this tutorial simply know that each camera has a default somewhere in the middle gray tones (~10-18% reflectance). Metering off of a subject which reflects more or less light than this may cause your camera's metering algorithm to go awry — either through under or over-exposure, respectively.

An in-camera light meter can work surprisingly well if object reflectance is sufficiently diverse throughout the photo. In other words, if there is an even spread varying from dark to light objects, then the average reflectance will remain roughly middle gray. Unfortunately, some scenes may have a significant imbalance in subject reflectivity, such as a photo of a white dove in the snow, or of a black dog sitting on a pile of charcoal. For such cases the camera may try to create an image with a histogram whose primary peak is in the midtones, even though it should have instead produced this peak in the highlights or shadows.

Metering Options

In order to accurately expose a greater range of subject lighting and reflectance combinations, most cameras feature several metering options. Each option works by assigning a weighting to different light regions; those with a higher weighting are considered more reliable, and thus contribute more to the final exposure calculation.

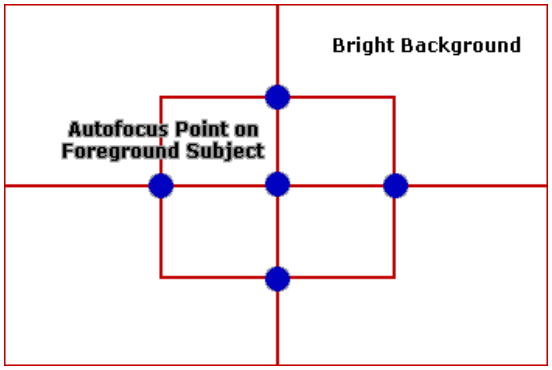

Center-Weighted


Partial Metering


Spot Metering

Partial and spot areas are roughly 13.5% and 3.8% of the picture area, respectively, although different camera manufacturers may use different values.

The whitest regions are those which contribute most towards the exposure calculation, whereas black areas are ignored. Each of the above metering diagrams may also be located off-centre, depending on the metering options and autofocus point used.



More sophisticated algorithms may go beyond just a regional map and include: evaluative, zone and matrix metering. These are usually the default when your camera is set to auto exposure. Each generally works by dividing the image up into numerous sub-sections, where each section is then considered in terms of its relative location, light intensity or colour. The location of the autofocus point

and orientation of the camera (portrait vs. landscape) may also contribute to the calculation.

When To Use Partial & Spot Metering

Partial and spot metering give the photographer far more control over the exposure than any of the other settings, but this also means that these is more difficult to use — at least initially. They are useful when there is a relatively small object within your scene which you either need to be perfectly exposed, or know that it will provide the closest match to middle gray.

One of the most common applications of partial metering is a **portrait of someone who is backlit**. Metering off of their face can help avoid making the subject look like an under-exposed silhouette against the bright background. On the other hand, care should be taken as the shade of a person's skin may lead to inaccurate exposure if it is far from neutral gray reflectance — but probably not as inaccurate as what would have been caused by the backlighting.

Spot metering is used less often because its metering area is very small and thus quite specific. This can be an advantage when you are unsure of your subject's reflectance and have a specially designed gray card (or other small object) to meter off of.

Spot and partial metering are also quite useful for performing creative exposures, and when the ambient lighting is unusual. In the examples to the left and right below, one could meter off of the diffusely lit foreground tiles, or off of the directly lit stone below the sky opening:

Notes On Centre-Weighted Metering

At one time centre-weighted metering was a very common default setting in cameras because it coped well with a bright sky above a darker landscape. Nowadays, it has more or less been surpassed in flexibility by evaluative and matrix, and in specificity by partial and spot metering. On the other hand, the results produced by centre-weighted metering are very predictable, whereas matrix and evaluative metering modes have complicated algorithms which are harder to predict.

Exposure Compensation

Any of the above metering modes can use a feature called exposure compensation (EC). The metering calculation still works as normal, except the final settings are then compensated by the EC value. This allows for manual corrections if you observe a metering mode to be consistently under or over-exposing. Most cameras allow up to 2 stops of exposure compensation; each stop of exposure compensation provides either a doubling or halving of light compared to what the metering mode would have done otherwise. A setting of zero means no compensation will be applied (default).

Exposure compensation is ideal for correcting in-camera metering errors caused by the subject's reflectivity. No matter what metering mode is used, an in-camera light meter will always mistakenly under-expose a subject such as a white dove in a snowstorm. Photographs in the snow will always require around +1 exposure compensation, whereas a low-key image may require negative compensation.

When shooting in RAW mode under tricky lighting, sometimes it is useful to set a slight negative exposure compensation (0.3-0.5). This decreases the chance of clipped highlights, yet still allows one to increase the exposure afterwards. Alternatively, a positive exposure compensation can be used to improve the signal to noise ratio in situations where the highlights are far from clipping.