

Color Temperature

“Color temperature” is distinctly different from “color” and also it is different from the warm/cold contrast described earlier.

Color temperature describes the actual temperature of a “black body radiator”. When an object is heated, some of its radiated energy becomes visible.

When a “black body radiator” is heated, its first visible color is a dull red, as the temperature increases, the color changes to orange, then yellow and finally white. Correlated color temperature is the “color match” of an object radiating light, when the source itself is not a “black body radiator”.

Although a tungsten filament is not a “black body radiator”, for ease of discussion, we will discuss color temperature and correlated color temperature as if they are one. Correlated color temperature can be understood as the color from a radiant source that matches a specific color radiating from a “black body radiator” at a specific temperature. Color temperature is measured in degrees Kelvin, and is designated by the capital letter “K”.

Working with Color Film

When shooting color film, your first consideration is the color balance of the film stock.

- Is the film I am shooting balanced for tungsten light or daylight?
- Is my light source appropriate for the film I am using?
- How can I use filters or gels to correct the color balance for the film I am using?
- Do I prefer to shoot without filtration, and to exploit the difference between the color temperature bias of the emulsion, and the prevailing color temperature of the light.

Color balance refers to the color temperature of the light that the film stock you are using “sees” as white light. Daylight balanced film stocks see 5500K as white light, whereas tungsten balanced film stocks see 3200K as white light.

Put another way - If one were to light something that is white with light that has a color temperature of 5500K, and photograph that object with daylight balanced film, the object would be rendered white. Similarly, if one were to light a white object with tungsten light, light that has a color temperature of 3200K, and photograph that object with tungsten balanced film, that object would be rendered as white.

However, if one were to shoot tungsten balanced film in daylight of 5500K, the image would have a bluish cast to it. And if one were to shoot daylight balanced film with tungsten light of 3200K, the resulting image would appear orange.

In order to shoot film under lighting conditions that do not match the film’s specifications for white light, a choice must be made: either a filter must be employed, or one must choose to shoot without matching the color temp of the light with the bias of the medium. Either is acceptable.

The most common example of this is when shooting tungsten film in daylight conditions. In this situation, an **85 filter** is commonly used to render what is considered to be “normal” results. The 85 filter absorbs 2/3 of a stop of intensity and so the exposure must be compensated.

The approximate color temperature of a few typical light sources are:

Match flame	1700K
Candle	2000K
Dawn Sunlight	2000K
40-60 watt tungsten light bulb	2800K
100-200 watt tungsten light bulb	2900K
500-1000 watt tungsten floodlights	3000K
Warm White Fluorescent Bulbs	3000K
Studio Tungsten Lamps	3200K
Projector Tungsten Lamps	3200K
Tungsten Halogen Lamps	3300K
Photoflood Tungsten Lamps	3400K
White Fluorescent Lamps	3500K
Cool White Fluorescent Lamps	4300K
Midday Sunlight	5400K
Typical Average Daylight	6500K
Overcast Sky	6800K
Hazy Sky	8000K
Clear Blue Sky	10,000-25,000K

Remember Daylight and Sunlight are not the same thing. Sunlight is the light from the Sun. Daylight is the light from the Sun mixed with the light from the sky as well as the light that bounces off the ground, buildings and other objects.

Mixing Color Temperatures

You may find that you want to mix light of different color temperatures to achieve a specific result. As a scene progresses, you may block your actors so they move from space illuminated by light of one color temperature to a space illuminated by light of another color temperature to parallel the psychology of the subtext and to lend greater visual impact to your story.

PHOTO Wide Shot of space-character in cool light PHOTO same shot, character has moved into close up, lit warmer.

Knowing that cooler (blues) colors recede and warmer (oranges) approach, you may simply choose to increase the sense of depth within your scene by mixing color temperatures. (using warmer colors in the foreground and cooler colors in the background)

When mixing color temperatures, you may find you prefer the results when using subtle differences, rather than drastic color shifts. Experiment with light and color to find the “look” that is appropriate for each film you shoot.

Lighting for Color

You will notice that in color photography, colors naturally separate from one another, unlike in black and white photography. When shooting black and white film, you need to build depth and separation into your shots by recording various tones, or shades of gray.

Flat lit Color Photo

B&W Photo

Color version of B& White Photo

Although colors separate naturally, you may find that you prefer the results you achieve when you light color film as if it were black and white (keeping in mind color temperature and design considerations). By using highlights and shadows to build depth and separation through contrast

of light and shadow (chiaroscuro), in addition to the natural separation due to color, you will create exceptional results.

Fluorescent Tubes

Strictly speaking, fluorescent tubes do not have color temperature, because they do not radiate continuous spectra. However, for convenience sake, we frequently use the term "color temperature" when referring to the color of their output.

Be aware! Unless you are using color corrected fluorescent tubes, or have applied the proper filtration, you will find an excess of green light when working with standard cool white fluorescent tubes or warm white tubes. You can reduce the green by using "minus green" gel. Minus green is a magenta gel that comes in various degrees of saturation--full minus green, half minus green, quarter minus green or eighth minus green.

When shooting color negative or reversal film specifically intended for printing or transfer, you can frequently "color correct" for the excess green in post. Keep in mind that mixing sources of various color temperatures can prove tricky, so you may want to add green to your other sources, so that when you color correct later, you remove all of the green equally. This practice requires testing so that you can achieve continuously predictable results.

Color and Skin

Different skin tones absorb some parts of the color spectrum, while reflecting others. Look carefully, when using colored lights on people to be sure that you are achieving the desired results. Unless you are trying for a specific effect, you may find that you prefer to photograph skin tones under "white light". That is light that your film sees as white, which depends on the color balance of your film stock.

Also keep in mind that color is recognized by its compliment. If you photograph a shot using red light to illuminate most of the scene, with white light illuminating your subject, your subject may still appear to have a cyan tint, because of the contrasting use of red light (remember Johannes Itten's principle of simultaneous contrast as described earlier).

White light is comprised of all the wavelengths of light in the visible portion of the electromagnetic spectrum. When juxtaposed against a light that consists of just one portion of the visible spectrum, the white light will have the tendency look like its complimentary color.

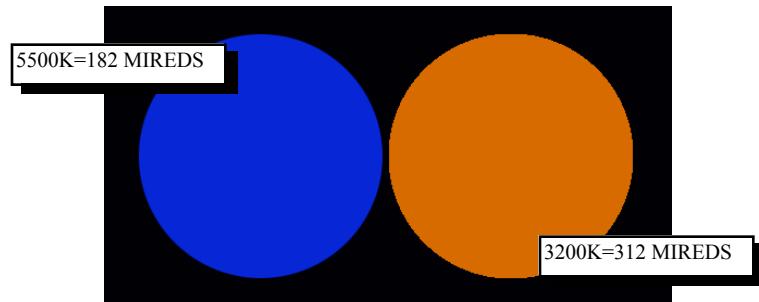
MIREDS

The MIRED System is an easy way to deal with the problems inherent in matching color temperature from different sources.

MIRED VALUE= $1,000,000/\text{color temperature (degrees Kelvin)}$ $=10^6/\text{K}$

Photographic Daylight is considered to be 5500K, which gives it a MIRED value of 182
 $(1,000,000/5500=182)$

A Studio Tungsten Lamp with a color temperature of 3200K, has a MIRED value of 312
 $(1,000,000/3200=312)$



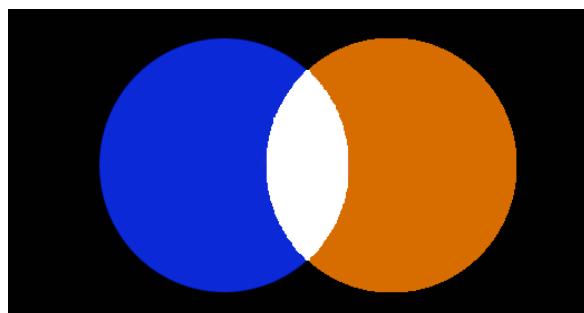
Gels and filters used in color photography for controlling color temperature have MIREDS values that are either plus (+) or minus (-) and indicate the color shift that they affect.

As you can see, the higher the color temperature, the lower the MIREDS value. As you raise a source's color temperature through filtration, you effectively lower its MIREDS value. Cooler gels, or gels that are blue in color, affect negative (-) MIREDS shifts in color. Warmer gels, or gels that are orange in color affect positive (+) MIREDS shifts.

Using the MIREDS system you can predictably and repeatedly control the color temperature of the light radiating from your sources so that you can achieve and maintain consistency from shot to shot.

In practical terms, if you have a light source that is 3200K and you want to balance it to another source that is 5500K, you need to lower its mired value from 312 to 182. This can be done easily by using a gel that affects a MIREDS shift of -130.

Gels can also be used to create areas of different color temperature within a scene, depending on the look that the cinematographer is trying to achieve.



Each manufacturer used different standards when manufacturing their products. When you want a gel that affects a MIREDS shift of -130, you may find yourself with a gel that affects a mired shift of -137. Don't worry, this difference is very slight and you will probably find that your results are quite acceptable.

What you will notice is that slight color shifts at the blue end of the spectrum are less noticeable than similar shifts at the red end. In other words the apparent difference between 5500K and 5700K is negligible to the eye, but a shift of 200K at the red end is much more obvious. The difference between 3000K and 3200K.

This may be because the shift at the red end represents a 6.6% change in color temperature, whereas at the blue end the same shift only represents a 3.6% shift.

Using Gels and Filters

The term “gel” refers to color altering filtration that is used directly between the light source and the subject it is illuminating.

The term “filter” refers to an optical element that is used between the film plane and the subject being photographed. Filters can be placed either in front of or behind the lens.

Given these definitions, one can see that using gels affects each individual light, one light at a time. And subsequently, a variety of gels can be used at the same time to create a unique “look” within a given moment. Or the same color gel can be used on several lamps to create a consistent overall look.

Using a color altering filter on the lens, will affect all of the colors, and will affect how the entire image is rendered.

There may be times, such as when shooting outdoors with tungsten balanced film that you want to employ an overall filter on the lens. An 85 filter will affect a MIRED shift which will allow your film to see the daylight as 3200K. Without the 85 filter, your tungsten balanced film will have an overall bluish cast. (the 85 filter blocks 2/3 of an f stop) *When shooting with tungsten light, if your 85 filter is in place, your image will be rendered very orange.

Some of the more common filters for color cinematography are:

Filters for Color:

Filter	Effect	Exposure increase in stops	MIRED Shift
85	Daylight > Tungsten (amber)	2/3	112
81EF	1/2 85 (amber)	2/3	52
80A	Tungsten > Daylight (blue)	2	-131



Filter	Effect	Exposure increase in stops	MIRED Shift
ND	Neutral Density. Reduces light passing through lens to film plane without altering color or depth of field		
Pola	Polarizer-polarizes light and blocks scattered rays only allowing parallel waves to reach the film plane	1 2/3 stops	