Lighting colour temperature and why it matters

Not all white light is created equal. **John Black** explains how this range, measured as colour temperature, impacts lighting design, and how both the eye and the camera lens see this spectrum

WITHOUT NECESSARILY EVEN knowing what lighting colour temperature is, the effects of different temperature light sources are clearly understood and experienced every day. I've often used the comparison of an up-scale retail store and a hospital wing in talking about the difference in how you feel in each environment due to lighting choice. I've also used the terms warm and cold to describe qualities of light and discussed how one or the other can be used effectively in a lighting design to affect how a viewer feels.

In this article, we're going to look a bit deeper into lighting colour temperature and why it matters to worship lighting techs. Hopefully you will come away with a better understanding of how it can be intentionally considered to improve your lighting designs.

Taken at Cornerstone Church in Toledo, Ohio, USA, the camera is colour balanced for the audience lighting, while the stage shows somewhat warmer (orangeish) because the stage lighting has a different colour temperature

What is lighting colour temperature?

Colour temperature is a way to describe the appearance of the light provided by a lamp and is measured in degrees of Kelvin (K). Most lamps will fall between 2,000K and 6,500K, and the measured colour temperature will let you know what the look and feel of the light produced will be. It is important to note that lamps are rated for colour temperature regardless of if they are incandescent, fluorescent or LED and it refers to the colour of the white light they produce. The lower the degree Kelvin, the warmer/more orange the light will be. The higher the degree Kelvin, the colder/more blue the light will be.

You will often see on the packaging of lamps – both residential and commercial – a colour temperature description for the lamp, as maybe even a word description used to describe common lamp temperatures. The following three descriptions are sometimes used:

Warm White lamps will generally be measured between 2,000K and 3,000K. These are most often used in residences, commercial retail, restaurants and other environments looking to create calm, inviting and intimate feelings.

Neutral White lamps will generally be measured between 3,100K and 4,500K. These lamps produce a neutral white light and are often used in work areas, basements, garages and other environments needing a bright, vibrant light source.

Daylight lamps will generally be measured between 4,600K and 6,500K. These lamps produce a blue–white light that most closely mimics actual daylight. They are often used in displays, garages, work areas and other environments needing crisp, cool light.

Why should you care?

Have you ever been looking at your lighting design with your eyes, and then looked through the lens of a camera at the same lighting and seen the reds or blues way over saturated or incorrectly reproduced? Or have you even panned a camera from the stage to an audience shot and the colours of the audience been thrown way out of whack? Chances are you have witnessed how the human eye and the camera eye can pick up completely different images of the same lighting look. Notice that all of the descriptions I used above are related to white light – and that's what colour temperature measures – the perceived colour of white light.

Human eyes are remarkable in that they can automatically adjust the perception of the colour of white light. This is not the case for other equipment requiring light, however, such as camera sensors and screens. Many digital products have options to auto white balance, allowing the device to adjust the way the sensor reads white light, but it's not perfect. As a result, most devices allow the operator to manually adjust the white balance so that what is recorded or broadcast is

Even illumination between both the worship stage and the congregation is camera friendly in this photo from Atlanta's historic Ebenezer Baptist Church

most accurately reproducing what the human eye sees.

As you can see, an understanding of colour temperature is extremely important if you work with cameras in your church. Even if you don't work with cameras, though, understanding colour temperature is important in all stage lighting design.

Colour temperature and the naked eye

If you are designing the lighting for a Christmas programme, drama or other situation in your church where realistic, theatrical lighting is needed, understanding colour temperature is important so that you can reproduce realistic lighting situations.

For example, if you are called upon to light a living room scene by the fireplace, understanding that the white light in that environment is very different from the white light used if needing to light an exterior scene on a rainy, overcast day. It would be confusing to the audience to be watching a fireside scene with the talent lit with a colour temperature over 5,000K, as well as lighting a rainy, overcast day with the talent lit with a colour temperature under 6,000K. In those examples, the perceived light doesn't match the temperature of the light in the real environments as we have experienced it.

In theatrical lighting, front light will often be provided in a combination of colours – warm, neutral and cool – which will be combined at differing levels such that scenes requiring a lower or higher colour temperature can be front lit appropriately and reproduce natural, realistic white light to the naked eye. This is very effective in stage lighting for live viewing. As you'll soon see, it is not as effective for lighting for cameras.

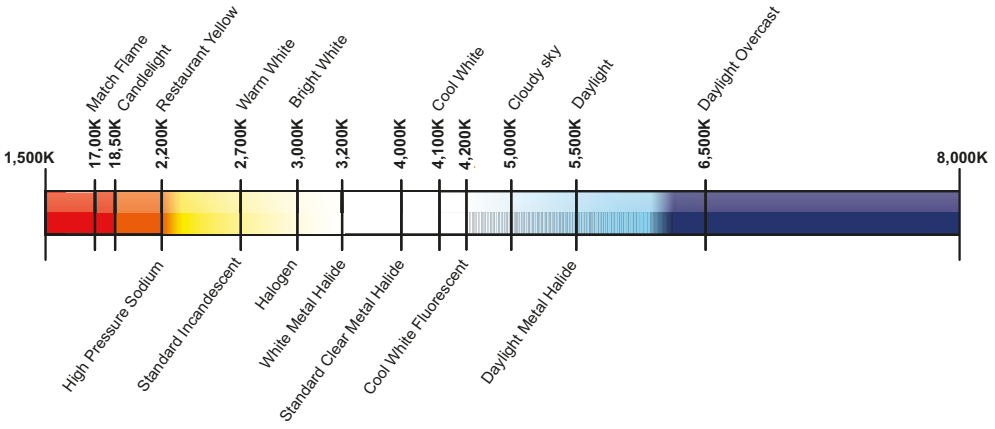
Colour temperature and cameras

As previously mentioned, the human eye has the ability to automatically adjust our perception of the colour of white light. This is beneficial to humans in that lighting rigs often use fixtures with lamp sources of various colour temperatures. I'll use some of my house fixtures as an example. I use 750W lamps in my ETC Source 4 fixtures that are measured at 3,050K at full intensity. To contrast, I use MSR 700 lamps in my PR Lighting XL700 fixtures that are measured at 7,500K.

The projected live broadcast of a service from Gateway Southlake church in Southlake, Texas, as seen at the satellite Gateway Frisco campus in Frisco, Texas. The projected image appears natural in colour balance, while the warmer colour temperature of the dimmed house lighting casts an orange hue over the congregation as seen by the camera (Photo by Jared Stump, CC BY-SA 3.0)

That's a wide temperature difference!

Unfortunately, camera sensors have difficulty with this kind of situation because they don't have a single reference for 'white light' across the whole rig. If set to auto-white balance, you may notice that the overall colour temperature of your camera recording or broadcast will re-adjust for various lighting looks during the same programme. The result could be an over-saturation of blues or reds even though the lighting looks fine to the naked eye.



The Kelvin temperature spectrum

What you can do

There are few churches nowadays that don't utilise cameras in some way – whether for IMAG (image magnification) in the auditorium, broadcast to the lobby and overflow spaces, streaming to the internet, or simply recording for on-demand or archival purposes. Ensuring the video looks good is just as important as ensuring the lighting looks good to the live audience. Coordinating the lighting between the lighting crew and the camera crew is important. The following three tricks are simple steps you can take to make working with cameras easier for your service.

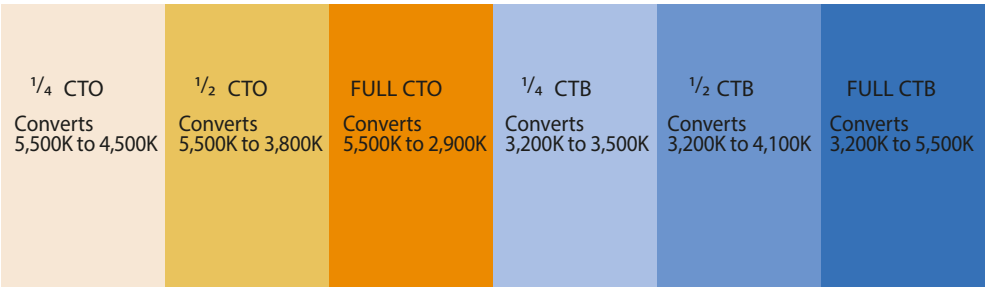
First, the lighting designer can work to match the colour temperatures of all of the light sources in the rig. This can be accomplished by matching the colour temperature of the lamps installed in the fixtures through the use of colour correction filters. Many moving head fixtures will have CTO (colour temperature orange) filters built in to bring down their colour temperature to match conventional fixtures with tungsten sources. Alternatively, CTB (colour temperature blue) filters can be inserted into conventional fixtures to bring their colour temperature up. These filters are often labelled with the degree Kelvin correction made to the source (converts 3,200K to 5,500K). By matching the colour temperatures of the fixtures in the rig, it will be easier for camera operators to white balance cameras and not have to make large adjustments throughout the service.

Second, in programming the lighting for the service, the lighting designer can try and minimise the fluctuations in intensity levels used in cues. It is important to understand that with lamps using a filament, changes in intensity will actually change the colour temperature of the light produced. If one portion of the service is lit at full intensity and the next at 50% intensity, chances are the cameras will need to be re-balanced to the new perceived colour temperature. During a rehearsal, pick an intensity that works for live viewers, and use that intensity throughout each part of the service to keep your camera operators happy.

Third, be willing to experiment and be flexible to change. It can't be put more simply other than cameras do not reproduce colours the same as the naked eye. Build in rehearsal time for the lighting team and video team to test each lighting look with real subjects to see what it will look like on camera. I have seen video monitors placed at lighting consoles so that the video being captured by the cameras can be seen and adjustments be made quickly if needs be by the lighting operator.

Both the audience and the digital viewers' experience are equally as important, and understanding why lighting colour temperature matters and what is needed will resolve many frustrations between the lighting and video teams.

These photos show the effects of colour temperature and white balance from a camera's perspective. The individual pictured, Jim Starzinski, director and principal audio engineer at NBCUniversal, was speaking during a DTV Audio Group event in a hotel multi-purpose event room with dimmed overhead room lighting. With a Canon SLR camera set for auto-white balance, the camera chose a colour temperature setting of 5,200K for both photos. That setting worked fairly well where the flash was employed. With the dimmed room lights only and no flash, the colour temperature setting on the camera was not suited to the colour temperature of the lighting, resulting in an orange tinted image. Manually recalibrating the colour temperature to 3,200K in a photo editor, which has a similar effect to using CTB gels on the source light (the lighting colour temperature would go up with CTB gels deployed, raising the colour temperature towards the camera setting), brought the second image closer to natural hues.



CTO and CTB filter correction gel colours and their relative effect

1. With Flash

2a. Without flash

2b. Without flash, Colour temperature adjusted to 3,200K

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