



## How to Choose the Right LED Lighting Product Color Temperature

Applicability: All LED Products

LED lighting offers many benefits and features that were difficult, if not impossible to offer with other lighting technologies. Many of the obvious benefits, such as substantial operating energy and cost reductions, longer life, and lower overall heat generation are generally well known. Another feature that allows for dramatic appearance and productivity benefits now and in the future, involves the color temperature of the light produced by LEDs.

### Lighting Color Temperature Measurement Beginnings

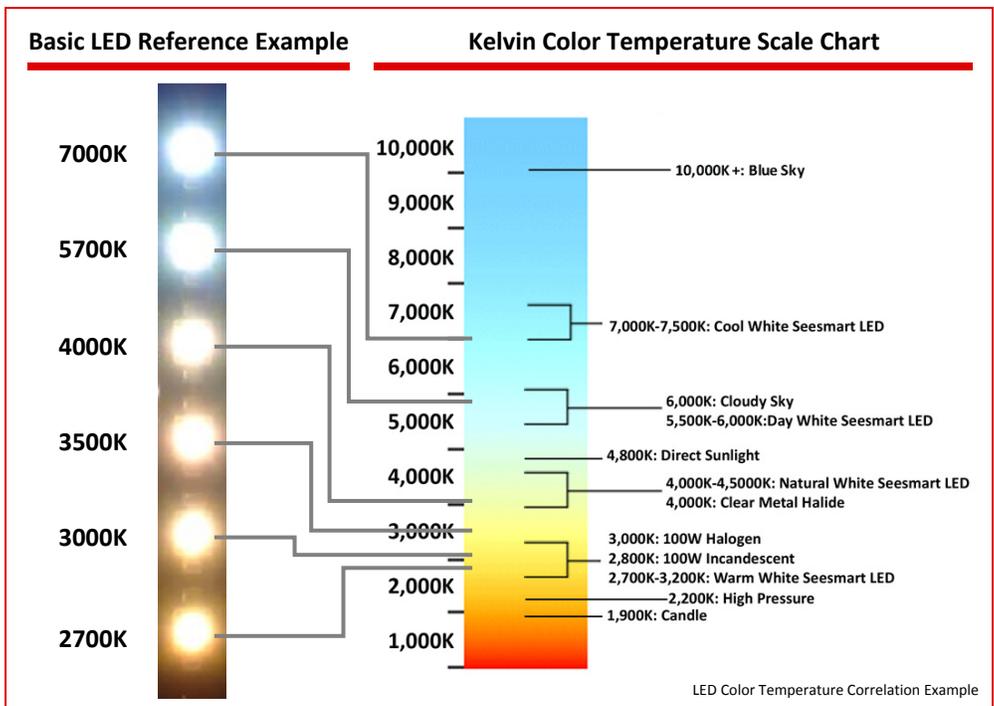
"White light" is commonly described by its color temperature. Measuring the hue of "white" light started in the late 1800s, when the British physicist William Kelvin heated a block of carbon. The block of carbon changed color as it heated up, going from a dim red, through various shades of yellow, all the way up to a bright bluish white at its highest temperature. The measurement scale for color temperatures, which was named after Kelvin as a result of his work, was based Centigrade degrees. However, since the Kelvin scale starts at "absolute zero", which is  $-273^{\circ}\text{C}$ , you can get the equivalent Centigrade temperature (compared to the visible colors of a heated black body) by subtracting 273 from the Kelvin color temperature.

### Color Temperature Scale Application

The term used in general illumination is correlated color temperature (CCT). CCT relates to the color of light produced by a light source, and uses the Kelvin temperature measurement scale (SI unit of absolute temperature). It describes the relative color appearance of a white light source, indicating whether it appears more yellow/gold ("warm") or more blue ("cool"), in terms of the range of available shades of white.

Many people are now familiar with the idea of a "warm" white or a "cool" white being offered by fluorescent and other light bulbs. These bulbs have vastly different color temperatures.

The "warm" bulb often has a color temperature of 3,000K and casts a more orange/red light on objects. Because you normally associate warmth with red or orange objects, this accounts for the "warm" descriptive name, even though it is a cooler (lower) temperature on the Kelvin scale. A "cool" white bulb commonly has a color temperature of 4,100K and higher on the Kelvin scale. This is in the low range of blue color, similar to ice, therefore earning the "cool" description.



## Color Temperature Measurement Basics



Sekonic C-500R Handheld Color Meter

Today, color temperature can be measured simply using a handheld meter, such as a Sekonic C-500R meter (shown in figure) where a reading can be taken in seconds with the press of a button. When the button is pressed, readings are taken from a group of sensors (blue, green, and one of two red light sensors behind the shield) and processed through algorithms to produce a Kelvin temperature reading that can be used for photography, verification, or simple reference purposes.



Same Lighting, Same Meter Position – Meter Reading Next to Non-Reflective Red Wall @ 5170K (left) Compared to Meter Reading Next to Reflective White Wall @ 5450K (right)

It must be noted that when using a handheld meter such as a Sekonic C-500R, it must be held closely to the light source or in the most neutral (average color, such as in the center of a room or space) in order to get an accurate reading of the color temperature of the light source and not the surrounding environment. For instance, if the light is held close to a red wall, the red reflection from the wall will skew the reading to the red end of the scale. Likewise, if held next to a white object or wall, the reading will be skewed higher. These skewed readings are illustrated in the Skewed Color Readings figure at right.

## Color Temperature Selection Considerations

So with choices now in lighting color temperatures, the question that often arises is, “how do I know what color temperature should I choose?” Should I have a certain color temperature in my warehouse, a particular color temperature in my offices, and then a specific color temperature in my lobby? In some cases the answer may be the same color temperature for all of those applications or it could indeed be different for each depending on the desired and/or required effect. Here are some suggestions on how to select the right color for your application.



Jewelry Cases – One with Day White @ 5800K (left) and Other with Natural White @ 4100K (right)

### Color Temperature and Purpose

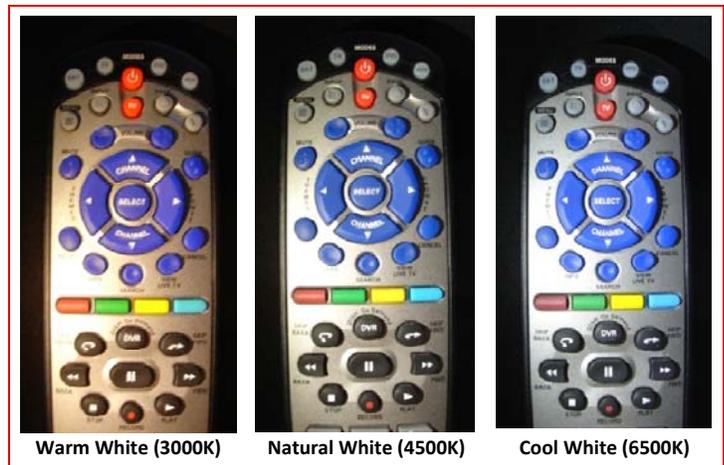
Color temperature in a room or space can have a dramatic effect on the people that use that lighting to perform tasks. For example, rooms that are used for tasks such as reading can benefit by incorporating lighting on the cooler end of the scale. Many studies have been done on classroom and work settings where reading improves when done under lighting near 5500K (Day White – 5500-6000K). See Seesmart’s “CS007 – Effects on School Children with Lighting Color Temperature Study” for additional information regarding the effect of color temperature in a school classroom. Warehouses also typically benefit from brighter white lighting, helping to see objects better and easier.

Retail locations can also benefit with higher temperature lighting from improved appearance of the product graphics and packaging along with a typically improved feeling of store patrons in the brighter light. Jewelry cases with crystal and diamonds would do great with Day White (5500-6000K) light, while wood tones and other jewelry may benefit more from a Warm (2700-3200K) or Natural White (4000-4500K) light. However, bright white lighting may not always be best if a certain amount of comfort or a particular mood is trying to be generated through the lighting, such as in a restaurant.

## Color Temperature and Appearance

Color temperature can affect the way things look in a space. If the décor is dominated by reds, browns, and oranges, you may want to illuminate these rooms with bulbs that have a color temperature in the warm white (2700-3000K) range. However, if the space has greens or blues, bulbs with more neutral to cool color temperatures (Natural White – 4000-4500K, Day White – 5500-6000K, or Cool White – 6500-7500K) should be used. If the space has a mix of colors, natural white (4000-4500K) bulbs should be used.

The figure to the right demonstrates basic appearance differences among the three basic color temperatures. However, the biggest and most noticeable difference can be seen between the Warm White and the Cool White LED lighting color on the same sample device. The red buttons in the Warm White photo stand out more than in the Cool White photo, while the blue buttons appear more vibrant in the Cool White example photo.



Object Appearance Differences with Color Temperature Differences

## Color Temperature and Mood



Just as wall finish and paint color can help determine an overall mood in a space, lighting color temperature can be used to determine and/or enhance a mood. For example, if the space is an intimate restaurant or a comfortable office setting, warmer color temperature lighting (in the 2700-3200K range) helps to convey a glow-of-the-fire type lighting that may be associated with a soothing and calming environment. Conversely, if a bright and airy environment is the goal, such as in a cafeteria, classroom, lobby, general offices, or certain retail stores, then cooler color temperature lighting (in the 5500-6000K range) helps to convey a sunny daylight type lighting that may be associated with nice pleasing outside conditions.

## Color Temperature and Personal Preference

Besides the considerations mentioned above, there is also one more decisive factor that may be used when selecting the appropriate product color temperature, personal preference. You may simply like or prefer the look of a particular light in a given space, foregoing any of the advice offered above. Additionally, there is a good chance that you may not have ever really looked at your lighting, have never cared about it (as long as it turned on every time you needed it), or just want whatever is up in the ceiling already because it is fine as it is without giving it anymore thought.

Whichever LED lighting color temperature you choose, you will enjoy the lighting and all of the other side benefits for a long time to come. Contact Seesmart® at 1-877-578-2536 between 9 a.m. to 5 p.m. PST, Monday through Friday or visit [www.seesmartled.com](http://www.seesmartled.com) for more information.