

## Tunable white and Circadian Rhythm

The white light coming out from an LED lamp is produced by blue LED die to excite the yellow phosphor on top of it. Different spectra of white light will vary with different CCT (Correlated Color Temperature), and the CCT can be

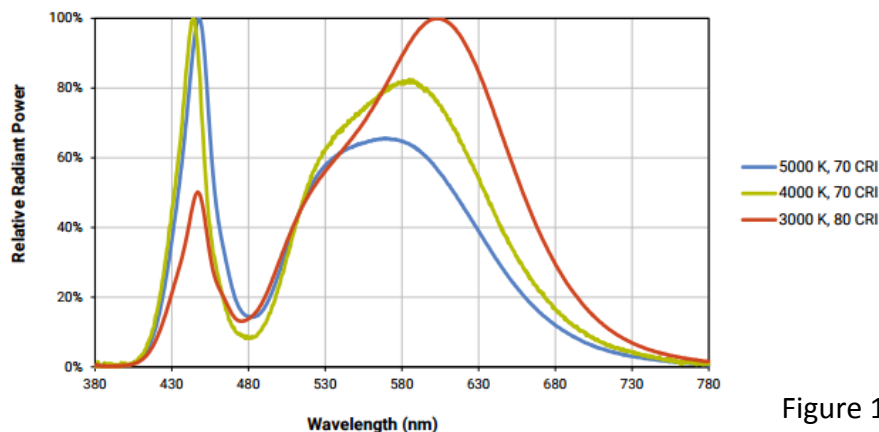


Figure 1

altered by changing the chemistry of yellow phosphor. Figure 1 illustrates the relative spectral power distribution of Cree XP-G3 LED lamps, and the spectrum of white light is clearly not a homogenous mix of wavelengths. The radiant power of blue wavelength (440 nm) for cool white (5000K CCT) is double of the warm white (3000K CCT). This is because cool white light emits more blue wavelengths and lesser red wavelengths, and thus it is perceived by human eyes as cooler or “bluer”. Warm white light has lower CCT than cool white because its output contains more red wavelengths and less blue wavelengths.



According to the studies conducted by Harvard Medical School and University of Toronto, blue light is a potent suppressor of Melatonin. Melatonin is a hormone, which creates the Circadian Rhythm (sleep-wake cycle) and helps people sleep. Higher level of Melatonin makes people sleepy, while lower level makes people alert. During the day, blue light is good for the body to stay alert, while minimal blue light in the evening is conducive for sleeping. In essence, cool white light (5300K CCT) is preferred in the daytime, and warm white (2700K CCT) is preferred in the evening.

Light of any wavelength decreases the secretion of Melatonin. Eye retina detects the light level and sends signals to the Hypothalamus. When it starts getting dark, the Hypothalamus signal to the body helps secrete the Melatonin. Figure 2 shows an illuminance of 300 lux suppresses the body to secrete 40% less Melatonin than 100 lux, according to a paper published by US National Library of Medicine National Institutes of Health. Thus, in the few hours leading up to bed, the light level in the room should be dimmed down substantially, so that the Hypothalamus realizes that it is getting dark now.

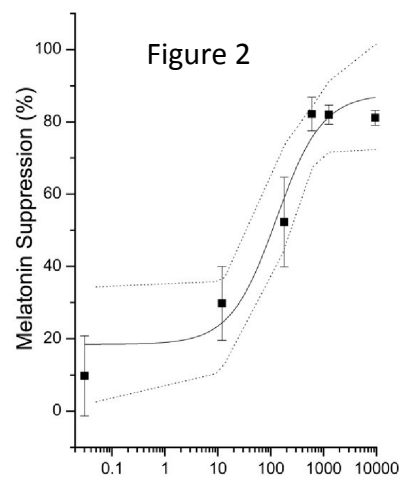




Figure 3

The above-mentioned medical studies show that the illuminance and blue wavelengths suppress Melatonin secretion. Thus it is more beneficial for the body to have brighter light with cool white color (containing more blue wavelengths) in the daytime, while weaker light with warm white color (containing lesser blue wavelengths) may be used in the evening. Also, if a person wants to simulate the natural light cycle of the sun as shown in Figure 3,

tunable white dimming LED fixture is the solution. This lighting application undoubtedly helps regulate the Circadian Rhythm, when a person stays indoor most of the time.

Tunable white fixture consists of 2 strings of LED lamps with different color temperature. One string of LED lamps is of 2700K CCT, and the other string of LED lamps is of 6500K CCT. By individually adjusting the light intensities of those two LED strings, desired color temperature can then be achieved. A typical setting of light intensities and color temperatures in a 24-hour interval is shown in figure 4. For instance, light of 300 lux and 5300K CCT is preferred in the morning, while 100 lux and 2700K CCT suits better in the evening.

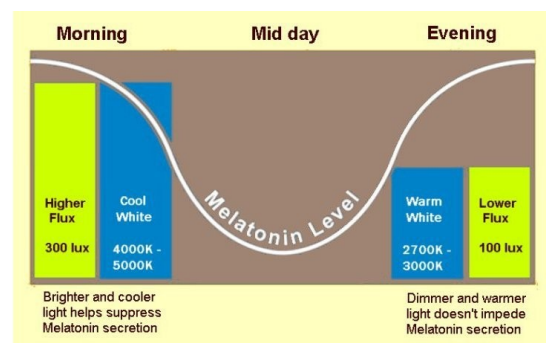


Figure 4



Figure 5

The Timer function of **DaliTablet** is specifically suitable to schedule the light intensities and color temperatures with accordance to the desired Circadian Rhythm. Three scenes are set within a 24-hour interval by **DaliTablet** shown in figure 5, and its settings are shown in Table 1. Brighter light with cool white color is scheduled after waking up in the morning, and dimmer light with warm white color is scheduled in the evening. In the daytime the light fixtures are turned off to save energy.

Scene	Time	Illuminance		CCT	
Scene 11	7:00 am	300 lux	Bright light	5300K	Cool white
Scene 12	10:00 am	0	Turned off	0	Turned off
Scene 13	6:00 pm	100 lux	Dim light	2700K	Warm white

Table 1