

## Physics of LED Light

LEDs emit light that has drastically different spatial, spectral, and temporal properties as compared to light emitted by traditional light sources such as tungsten filament.

### Spatial Properties

A traditional light source, such as shown in the column on the left in Figure 1, emits light essentially uniformly in all directions in space. An LED, on the other hand, due to the flat surface geometry, emits light in a direction, and the light within the directional beam is not spatially uniform, as shown in the column on the right.

A lux meter can be used to measure the intensity of the light from a traditional light source by measuring the illuminance and then calculating the luminous intensity. However, a lux meter cannot be used for an LED light source because the LED chip emits high intensity light from such a tiny flat surface and because the light is not uniform in energy. Only computer modeling can be used to accurately calculate the intensity pattern of light from an LED source.

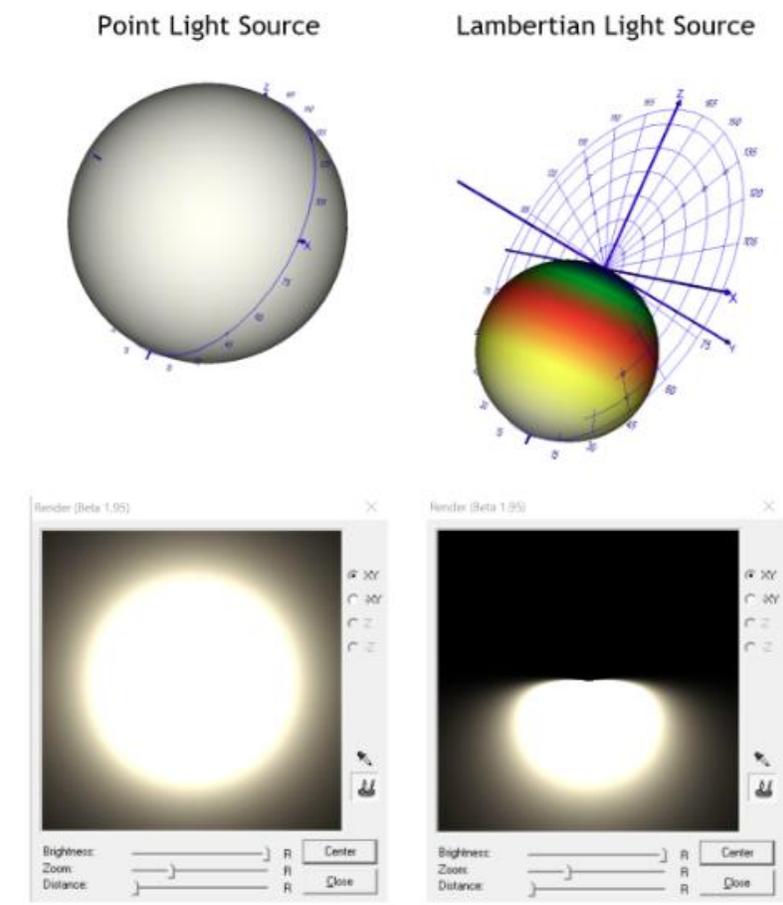


Figure 1 - Spatial Properties<sup>1</sup>

<sup>1</sup> <https://luminusdevices.zendesk.com/hc/en-us/articles/4411289188109-Optical-What-do-the-Radiation-Plots-in-LED-datasheets-mean-and-how-do-I-calculate-Lux>

## Spectral Properties

A tungsten filament light has a smooth curve of spectral power distribution, ranging from low blue to high red and infrared, as shown in Figure 2.

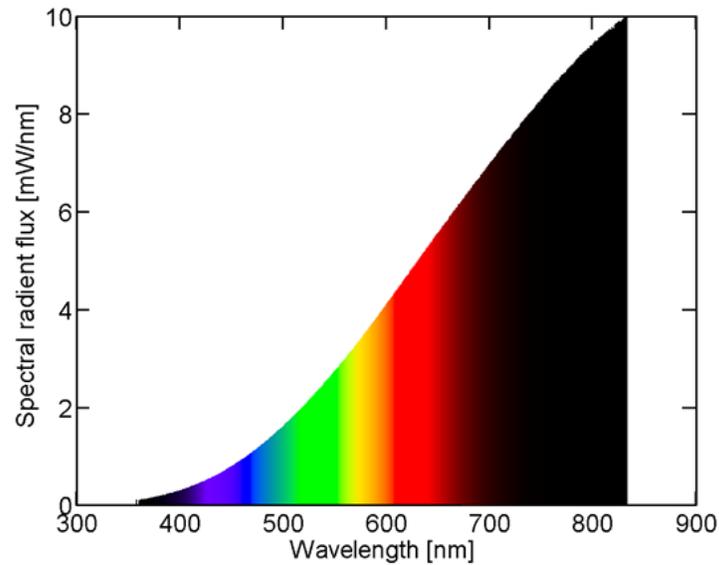


Figure 2 - Spectral Power Distribution of Incandescent

A 4000K LED has a spectral power distribution consisting of a sharp peak of blue wavelength light, very little red, and no infrared, as shown in Figure 3

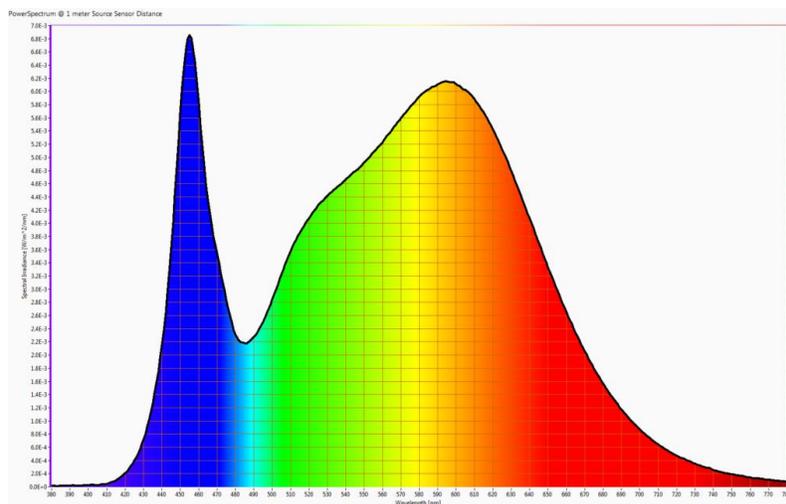


Figure 3 - Spectral Power Distribution LED

## Temporal Properties

An incandescent light bulb has sine wave flicker with about 6.6% percent flicker when connected to an A/C source, as shown in Figure 4.

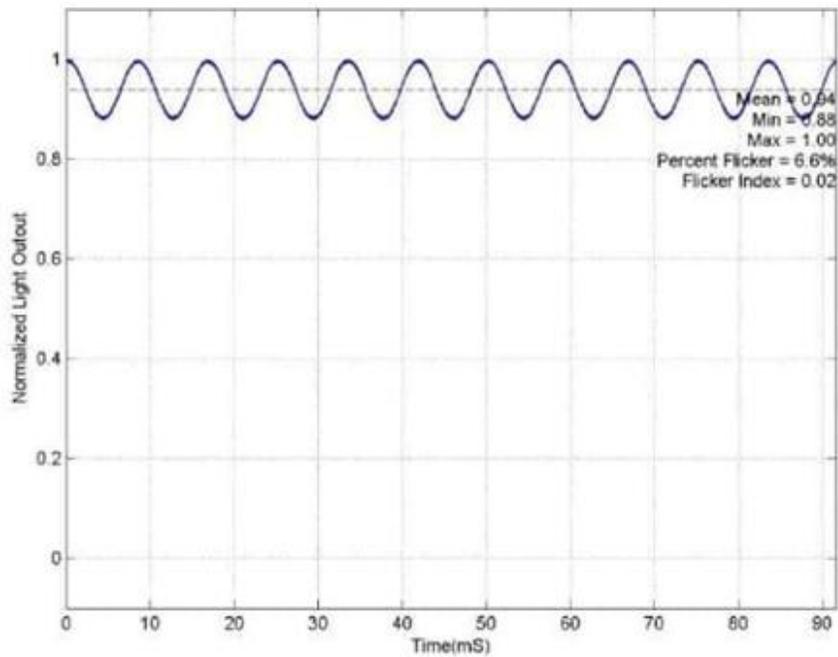


Figure 4 - Sine Wave Flicker

An LED exhibits square wave flicker with 100% percent flicker when connected to an A/C source, as shown in Figure 5. This graph also shows the effects of Pulse Width Modulation using an LED.

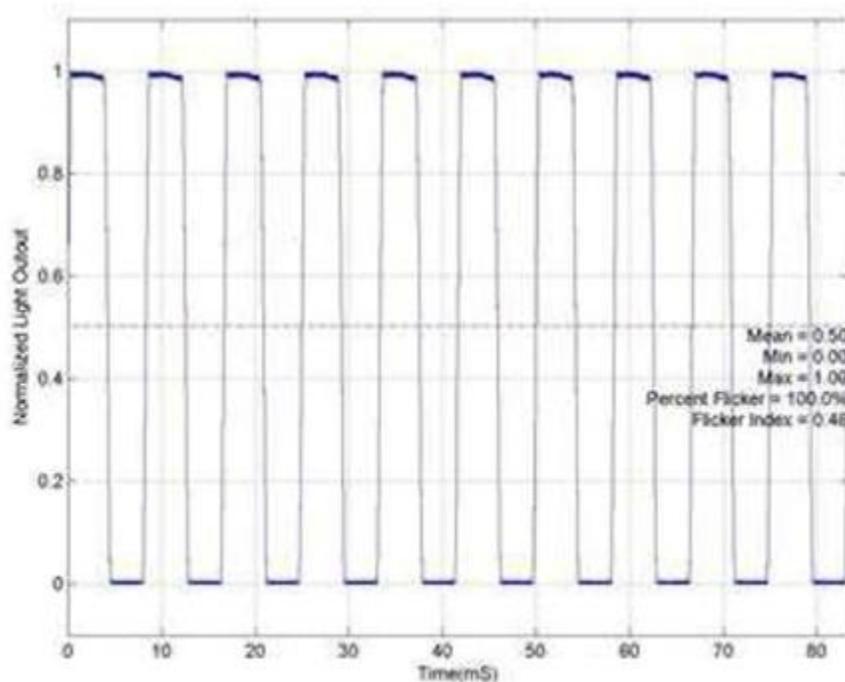


Figure 5 - Square Wave Flicker