Real Lumens versus “LED Lumens”

Light Output Measured in Lumens is a Key Purchase Criterion

In the highly competitive world of projection displays, a projector’s light output level is a key purchase criterion. Distributors, retailers, and consumers compare light output ratings from manufacturers because the light output level is a critical determinant of the projector’s display performance.

Projector light output is measured in lumens, a unit of luminous flux. Lumens are dimensionally equivalent to Watts, a unit of power which analogously refers to radiant flux. The difference is that radiant flux refers to broad spectrum power, whereas luminous flux is radiant flux weighted according to the human eye’s spectral sensitivity, i.e. the photopic curve. The important point is that a projector’s lumen rating refers to the amount of optical power that the projector can deliver to a screen.

Standardized Method of Measuring Projector Light Output

Owing to the importance of having a standardized method to measure a projector’s light output, the American National Standards Institute (ANSI) originally released ANSI IT7.215 in 1992. This standard was later updated, in 1997, to ANSI IT7.228. Industry uses the term “lumens” to refer to this methodology, and this term remains in common use today to refer to a projector’s light output level. The same methodology was also adopted by the International Electrotechnical Commission (IEC) in IEC 61947-1, released in 2002, the same method appears as well in a much more recent IEC document, 62906-5-1, released in late 2021, and this same basic methodology also appears in ISO 21118, originally released in 2005 and most recently re-released in 2020. Therefore, industry has agreed on the standardized method for measuring the lumen light output level of a projector. Furthermore, this method has been consistently applied for more than two decades.

“LED lumens”

In order to promote their products and attract potential customers, some projector manufacturers have advertised light output levels of their products using non-standardized methods. In general, showing a higher number suggests more capability, which could well be the intent of deviating from the standard. However, the use of alternate methods may convey an overstated or inflated sense of a projector’s actual capability.

Recently, the term “LED lumens” has appeared in marketing documents. One manufacturer has even written a white paper entitled “Understanding the Difference between ANSI Lumens and LED Lumens”.[1] That paper describes an aspect of human perception, the Helmholtz-Kohlrausch (HK) effect, whereby more saturated colors can appear brighter. The paper goes on to claim and apply an unsubstantiated light output amplification factor, based upon perceived color saturation of their selected light source, whereby the standardized lumen rating is multiplied by 2.4x to get the “LED lumen” rating. The reader should be aware of several points from this manufacturer's misleading white paper:

1) “LED lumens” is Not Standardized

The term “LED lumens” appears in quotes in this paper as it is a marketing term. Importantly, there is no known standard for measurement of the so-called “LED lumens”. It is deceptive to use “LED lumens” in lieu of or in addition to ANSI or ISO lumens, the methodology which has been standardized and published by multiple accredited and internationally recognized organizations. “LED lumens” has never been standardized.

2) “LED lumens” is Not an Industry Accepted Term

Unsurprisingly, the term “LED lumens” has only been used by certain projector manufacturers who have selected LEDs as their light source. While certain projection manufacturers may wish to promote their specific choice of technology, there are nevertheless multiple methods to generate narrowband, highly saturated sources of light to create a projected image. Such sources include saturated LEDs, but also lasers, phosphor converted light sources, and quantum dot converted light sources. LEDs are not the only means of generating saturated light. Nor are LEDs necessarily saturated: LEDs can also generate broad-spectrum light, such as white light for room illumination, headlamps, and LCD backlights. Regardless of the type of light source that is used, the same internationally recognized method of measuring a projector’s light output can and should be applied.

3) There is no Standard for Measurement of Helmholtz-Kohlrausch Effect

Standardizing any purported HK benefit to apparent brightness is a challenge, because the HK effect depends on the specific viewer*, on ambient lighting conditions (luminance and chromatic adaptation), on saturation levels of the displayed content, and on other factors. Perhaps for this reason, claims of HK effect benefit have ranged from 1.3x to 2.4x, a wide spread.[2,1] Importantly, the term HK effect is related to apparent brightness. Brightness is a matter of perception, unlike lumens, which is a measure of luminous flux, a viewer-independent metric that can be measured using standard instrumentation.

To further the point, consider the analogy of temperature. The HK effect and "LED lumens" are based upon perception. If temperature is described in terms of "hot" or "cold", there is no standardized definition for "hot" or "cold" and perceptions of these terms can vary widely from person to person. Contrast this subjectivity with the standardized definition for temperature that uses instrumentation to measure degrees Celsius. A temperature of 26 degrees Celsius is always 26 degrees Celsius and not subject to individual bias. Analogously, the ISO/IEC/ANSI standardized method has been used for decades to measure the lumen light output of a projector—it is standardized, measurable, repeatable and not subject to human perception.

4) No Method has been Standardized to Incorporate the HK Effect in Displays

To date, the HK effect has not been included in any electronic display standard. A standardized method for quantifying any HK effect benefit would start with cross-industry agreement on test conditions and content, with agreement on minimum number of subjects for testing, and with a baseline display with specific properties. This first step has yet to happen. Open data sharing and cross-industry consideration of test results would follow.

Conclusion

We caution against the use of non-standardized methods to determine the light output of a projector. "LED lumens" is not based on any standard, and may have been developed with an intent to persuade or even mislead consumers. Reliance on such a rating could lead to misguided purchase decisions. The ISO/IEC/ANSI method is the industry's accepted and standardized methodology for measuring a projector's light output level.

References

[1] *ViewSonic Whitepaper—Understanding the difference between ANSI Lumens and LED Lumens. https://www.viewsonic.com/eu/products/projectors/lumens/*

[2] *Liao, Shih-Fang, Hung-Yu Chou, Tsung-Hsun Yang, Cheng-Chung Lee and Kirk Chang. "Perceived Brightness of LED Projector." Society for Information Display 40, no. 1 (2012): 262-264. https://doi.org/10.1889/1.3256758*

*As an extreme example, consider a viewer with colorblindness. Such a viewer will not experience the HK effect.