

Xicato® XIM and XTM TM-30-15 Metrics

Purpose / Objective of This Document

The goal of this document is to provide TM-30-15 metrics of Xicato modules and compare the new TM-30-15 metrics with the currently used color rendering metrics like CIE Ra , CIE R9 (for red color rendering) and Gamut Area Index (GAI).

TM-30-15 is a new method for quantifying color rendering properties of light sources that was recently published by the Illuminating Engineering Society. It distinguishes both color fidelity and color gamut and provides a framework for interpreting chroma and hue shift associated with light sources.

Procedure / Tools Used

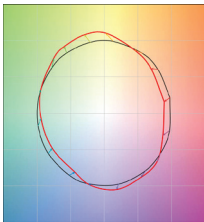
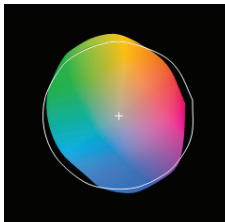
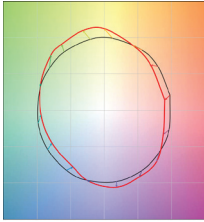

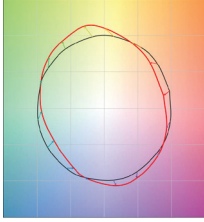

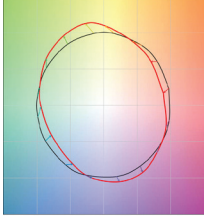

Spectral power distribution data was collected from a wide range of modules, spanning multiple production batches and dates.

STANDARD SERIES	ARTIST SERIES®	VIBRANT SERIES® V80	VIBRANT SERIES® V95
2700K	2700K		
3000K	3000K	3000K	3000K
3500K	3500K		
4000K	4000K		

The spectral data was collected at an operating temperature of 70°C which is representative for the temperatures of modules inside fixtures. Spectra were sampled both at 1nm and 5nm interval between 380nm and 780nm. For metrics calculation, the excel tool TM-30-15 Advanced Calculation Tool v1.99 was used.

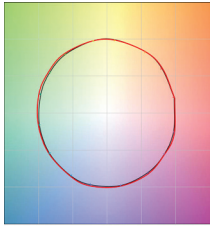
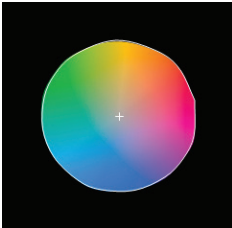
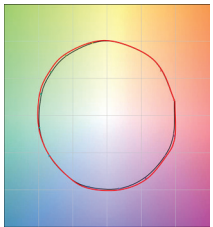
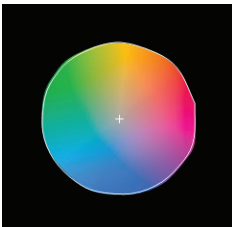
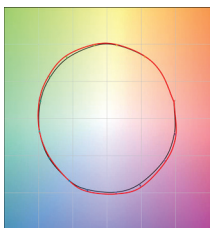
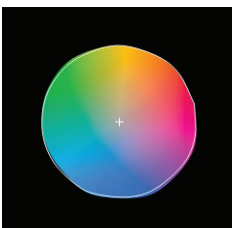
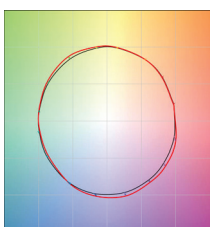
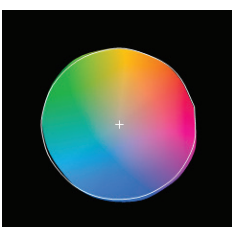
Results

Standard Series

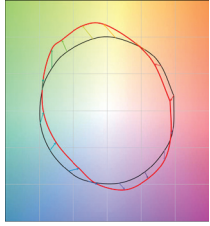

CCT	CIE R _a	CIE R ₉	TM30-15 Rf	TM30-15 Rg	Color Vector Graphic	Color Distortion Graphic
2,700K	83	16	80	99		
3,000K	83	16	78	101		
3,500K	83	16	77	101		
4,000K	83	16	77	101		

Color Vector Graphic legend:
Red line: test source
Black line: reference illuminant

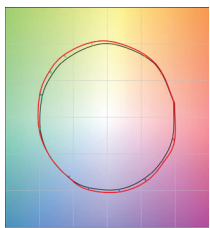
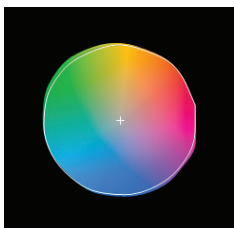
Artist Series

CCT	CIE R _a	CIE R ₉	TM30-15 Rf	TM30-15 Rg	Color Vector Graphic	Color Distortion Graphic
2,700K	98	98	96	102		
3,000K	98	98	96	103		
3,500K	98	98	95	103		
4,000K	98	98	93	103		

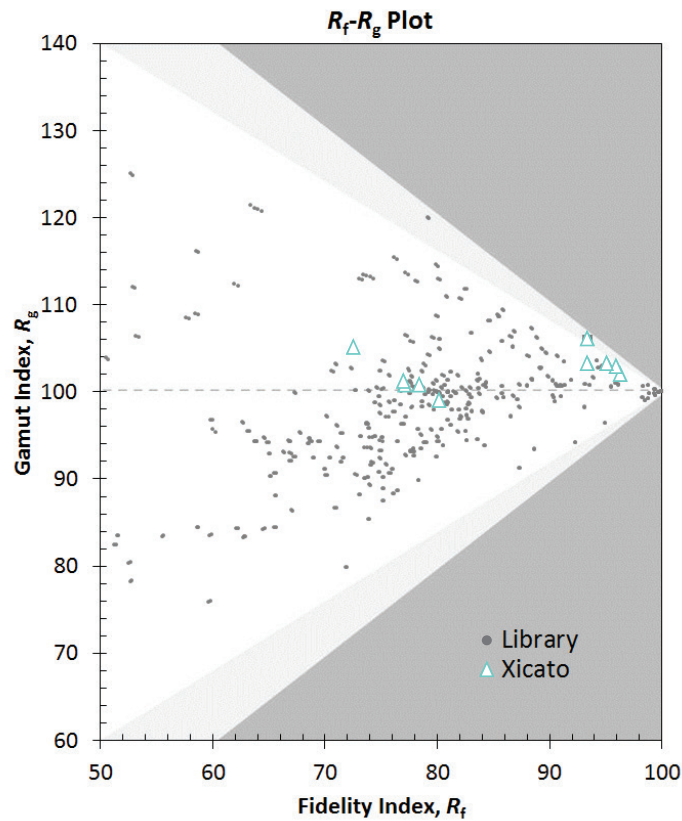
Vibrant Series V80

CCT	CIE R_a	GAI	TM30-15 Rf	TM30-15 Rg	Color Vector Graphic	Color Distortion Graphic
3,000K	83	111	77	105		

Vibrant Series V95

CCT	CIE R_a	GAI	TM30-15 Rf	TM30-15 Rg	Color Vector Graphic	Color Distortion Graphic
3,000K	95	120	93	106		

Results for Xicato Modules in Rf-Rg Plot



Xicato results are shown with green outline triangle markers.

Discussion

For the Xicato modules evaluated, results for Rf correlate with CIE Ra with Rf overall being around 2 points lower. Rg provides numbers that are quite different from GAI; the difference can be 6 to 13 points. Looking at Rf and Rg combined, it can be seen that Xicato Artist Series® successfully combines the best of both worlds and comes close to incandescent sources (that are by definition of 100Rf and 100Rg because they are black body radiators that TM-30-15 uses as reference source). Xicato Vibrancy V95 (V930 in the Rf-Rg chart) combines both high fidelity with an increase in gamut beyond 100.

Even though the calculated Rg values between Xicato Standard Series and Xicato Artist Series® are similar, the lit effect between the two is very different, as is also illustrated in the Color Vector Graphics and Color Distortion Graphics which are distinctly different for both series.

Hue Shift

Vectors pointing along the circumference of the diagram in the Color Vector Graphic indicate hue shift. For example, orange can be represented by a test source as yellow-orange or green as yellow-green. As can be seen from all Xicato sources, the vectors point inward or outward, but not along the circumference of the diagram. Consequently it can be concluded that hue shift is minimal for all Xicato sources.

Changes in Chroma

When the colored area from the Color Distortion Graphic extends beyond the white line of the reference source, it represents chroma enhancement (colors appear more saturated). Similarly, if the colored area “shrinks” to within the white line, a decrease in chroma is represented (colors will look faded). By design, different Xicato color rendering series affect chroma in different ways, as can be clearly seen from the Color Distortion Graphics. Xicato Artist Series® matches chroma of the test source very accurately and provides minimal color distortion. Xicato Vibrant Series® has been optimized to increase chroma in the yellow-green and red-violet regions. Xicato Vibrant V95 Series especially does this without compromising chroma in areas that are not enhanced.

When comparing different light sources, the lit effect of lightly colored objects is only partially represented with TM-30-15 like color metrics. The accuracy of the light source white point has a big impact on how lightly colored objects are perceived. This is most

easily seen for white objects that reflect all wavelengths equally. Inconsistent white points of multiple light sources can make a uniform surface of a lightly colored object appear non-uniform in color. In most cases this will not be desired. Because of this effect, it is important to specify light sources with a tight white point tolerance. Xicato recommends a specification of 1x2 MacAdam ellipse with a maintained color consistency of $du'v'$ of 0.003 or smaller over 50,000 hours for any source in an installation.

Conclusions

- Comparing TM-30-15 Rf and CRI - there are small shifts for Xicato sources, Rf being typically 2 points lower than CRI. Between TM-30-15 Rg and Gamut Area Index, the numbers can be quite different, in the range of 6 to 13 points.
- All Xicato sources show minimal hue shift in color vector graphics.
- Xicato Artist Series® scores very high in both Rf (96) and Rg (102). Color vector and color distortion graphics show minimal differences versus relative standard illuminants.
- In real life applications, white point accuracy has a great impact on lightly colored objects. Therefore a tight specification is required for uniform appearance. Xicato recommends 1x2 MacAdam ellipse for color accuracy and a shift of less than 0.003 $du'v'$ over 50,000 hours for any source in an installation.

References

For information on TM-30-15:
<https://www.ies.org/store/product/ies-method-for-evaluating-light-source-color-rendition-3368.cfm>

For information on Gamut Area Index:
<http://www.xicato.com/technology/color-gamut>

For more information on different color rendering options from Xicato:
<http://www.xicato.com/quality-light/natural-light> and <http://www.xicato.com/quality-light/vibrancy>