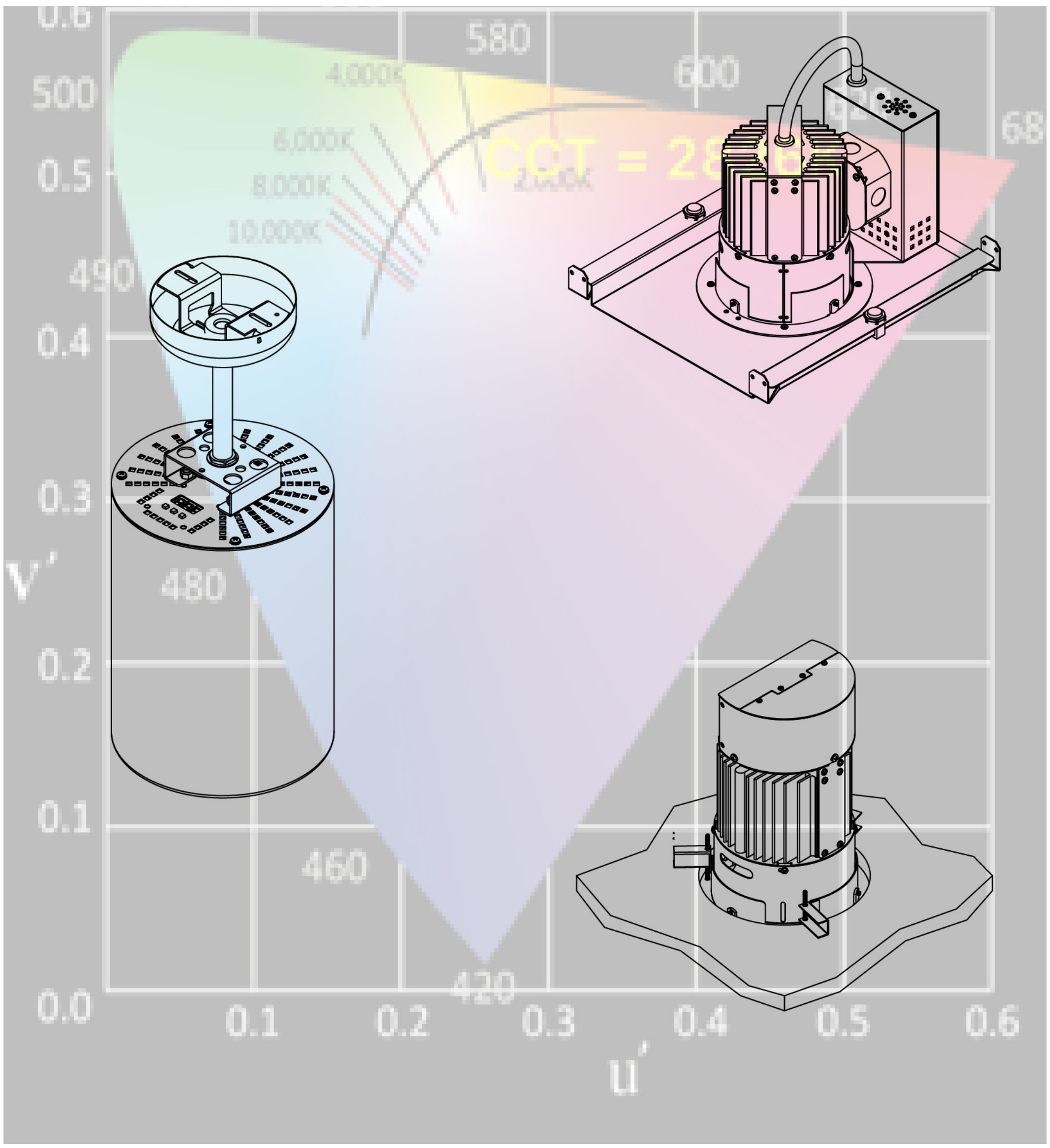
ALTMAN Lighting

BRINGING IMAGINATION TO LIGHT



CDR70 / CDP70 Luminaires Photometrics Guide

Have a question regarding this guide?

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Should you find an error, have a suggestion or question regarding your Altman Lighting product, we would love to hear from you.

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Our Commitment

Altman Lighting continually engages in research related to product improvement. New materials, production methods and design refinements are introduced into existing products without notice as a routine expression of the philosophy. For this reason any current Altman Lighting product may differ in some respect from its published description, but will always equal or exceed the original design specifications unless otherwise noted.

Manual Part Number: **CDX70-TM30-GUIDE**

Version as of: **31 May 2017**

CDR70 / CDP70 Luminaires Photometrics Guide

TABLE OF CONTENTS

PREFACE

About this Guide

The document provides photometric information for the following products:

- CDY70 Yoke Mount (portable)
- CDW70 Wall Mount
- CDP70 Pendant Mount (stem and aircraft suspension cable)
- CDR70 Recessed Mount (new construction and remodeler)

Note: Additional product information, including product specification sheets and manuals, can be found on our web site at www.altmanlighting.com.

About TM-30-15

In our this guide we include a "score card" that outlays TM-30 Data. The Illumination Engineering Society's (IES) TM-30-15 is the most recently developed method of evaluating color rendition and is garnering a lot of attention in the lighting community. TM-30-15 seeks to supplant CRI as the industry standard for measuring color rendition. Recently, we have observed a significant interest in TM-30-15 among our customers.

What is TM-30-15?

TM-30-15 is a method of evaluating color rendition. It comprises three primary components:

- **Rf:** A fidelity index that is similar to the commonly used CRI. Color Fidelity (Color accuracy or color balance)
- **Rg:** A gamut index that provides information about saturation.
- **Color Vector Graphic:** A graphical representation of hue and saturation relative to a reference source.

Note: More about the solid state lighting, understanding TM-30 measurements, FAQs, etc. can be found on US Department of Energy (DOE) website at https://energy.gov/eere/ssl/solid-state-lighting.

What are the differences between TM-30-15 and CRI?

There are a few important differences. The following parameters offers a better explanation and measurement of the performance of LEDs.

First, CRI (color rendering index) provides information only about fidelity, i.e. the accurate rendition of color such that objects appear similar to how they would under familiar reference illuminants such as daylight and incandescent light. However, CRI doesn't provide any information on saturation. The picture below shows two images with the same CRI and different levels of saturation. While the images obviously look very different because of different saturation levels, CRI does not provide a mechanism of describing these differences. TM-30-15 uses the Gamut Index (Rg) to describe differences in saturation. For more information, refer to cosponsored by the IES and DOE.

Second, whereas CRI uses only eight color samples to determine fidelity, the TM-30-15 uses 99 color samples. A lighting manufacturer could 'game' the CRI system by ensuring that certain peaks of the light source spectra matched one or a few of the eight color samples used in calculating CRI and thus achieve an artificially high CRI value. Such an artificially high CRI value would result in a lower TM-30-15 value since TM-30-15 has 99 color samples. After all, matching spectrum peaks to 99 color samples is very difficult!

Fidelity Index (Rf)

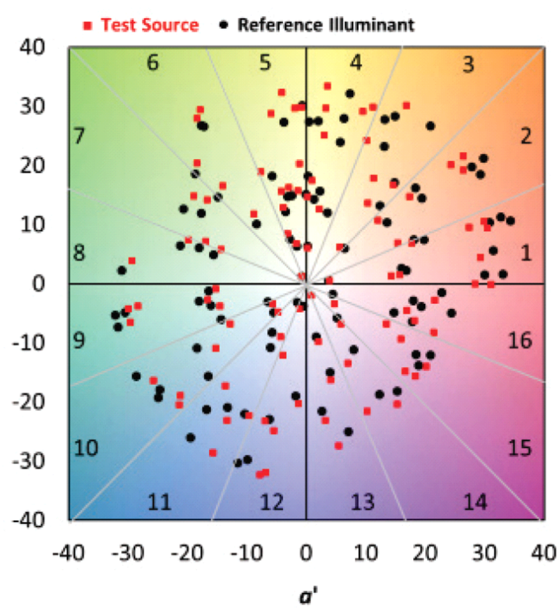
In TM-30, there are 99 Color Evaluation Samples (CES). By comparing the chromaticity coordinates of the 99 samples when illuminated by the test source and the reference source, and calculating the average change, we can calculate the fidelity index, or Rf. The range of this value is from 0-100, with 100 indicating identical appearance.

99 Color Evaluation Samples

It is important to note that some sources may have lower or higher Rf values than CRI values. For example, a light source could have been previously optimized to portray the 8 color samples only so it scored high with CRI.

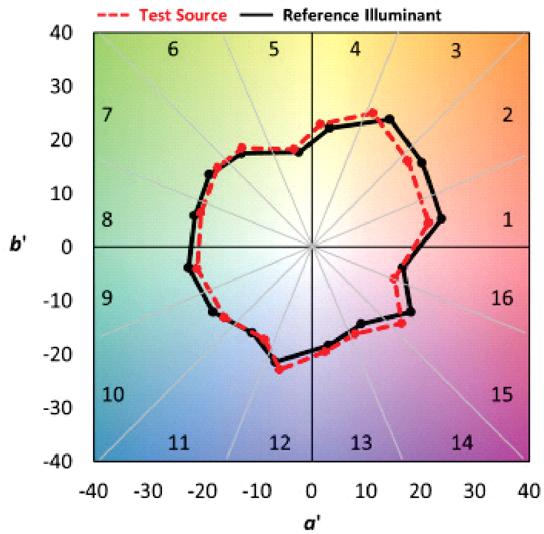
Gamut Index (Rg)

The second measurement used in the TM-30 is the gamut index, Rg, which determines the increase or decrease in chroma for the given light source. It compares the 99 CES under the test and reference illuminants. In the graph below, each CES is represented by both black and red dots. The black dots are each CES under the reference illuminant. The red dots are each CES under the test light source. You can see that with some areas, the black and red dots are very close which means that sample looks almost the same under the reference illuminant and the test light source. The further apart the two dots are, the higher the shift in color between the two.



Chromaticity Coordinates of the 99 Samples

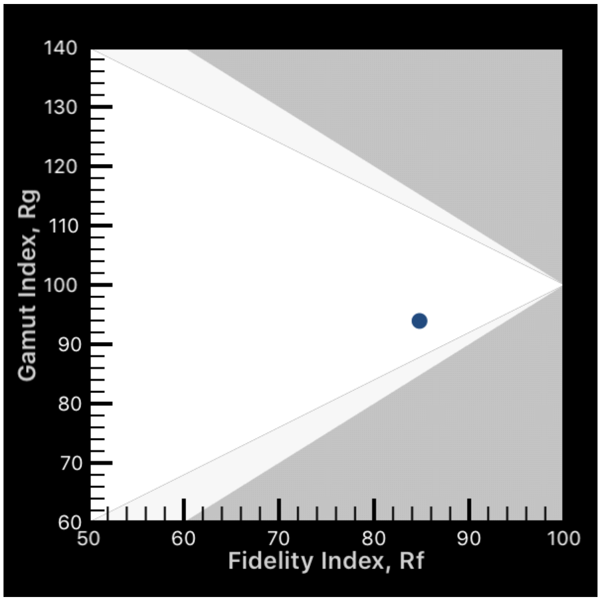
But the question remains, how is the Rg value calculated? The (a’, b’) plane is cut into 16 sections (numbered on graph). The arithmetic mean of the a’ and b’ coordinates of all the samples in each section for both the reference source and test source result in 32 coordinate pairs. The 16 pairs for the reference source and the 16 pairs for the test source are plotted on the same graph and each make up a similar polygon. Rg is calculated as 100 times the ratio of the area of the two polygons. It is important to keep in mind that this calculation determines the average gamut area for all of the CES and not the largest possible area defined by the most saturated samples only. This is how the calculation is performed because it is better to represent all colors rather than just a subset of the most saturated colors.



If the test source does not increase or decrease in saturation compared to the reference source, the Rg value will be 100. If the value is over 100, this indicates an overall increase in saturation. If the Rg value is less than 100, there is an overall decrease in saturation. There is no maximum value for Rg but the possible range does increase as Rf decreases. For example, if the Rf value of a light source is 80, the Rg value is bound to a possible range of approximately 80 to 120.

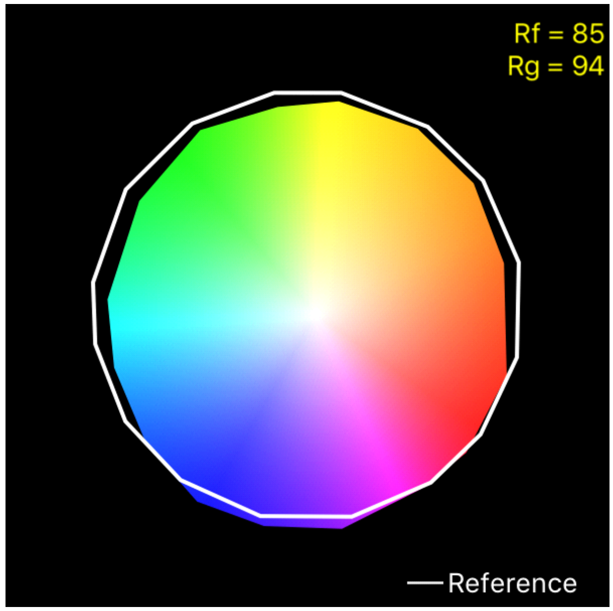
Now that we have values for both Rf and Rg, it is easier to see how it works through graphical representations. The color vector graphic shows which colors are saturated or desaturated and which colors undergo a hue shift. The reference illuminant is normalized to a black circle and the gamut of the test source is plotted relative to the circle. Arrows that point into the black circle indicate areas of decreased saturation while areas that point out of the black circle indicate areas of increased saturation. Arrows that do not point directly to the center of the circle or directly away from the center of the circle are representing hue shift.

The graph below shows the relationship between Rg and Rf. The white area denotes approximate limits for light sources on the black body locus. The light grey area denotes approximate limits for practical light sources. As the test point gets higher on the gamut index axis, it gets more saturated. The lower it is, the less saturated. As the test point gets lower on the fidelity index axis (closer to 50), the hue shift for that source increases. The Rf vs. Rg plot is mainly used as a visual reference which helps to compare different light sources.



Color Vector Graphic

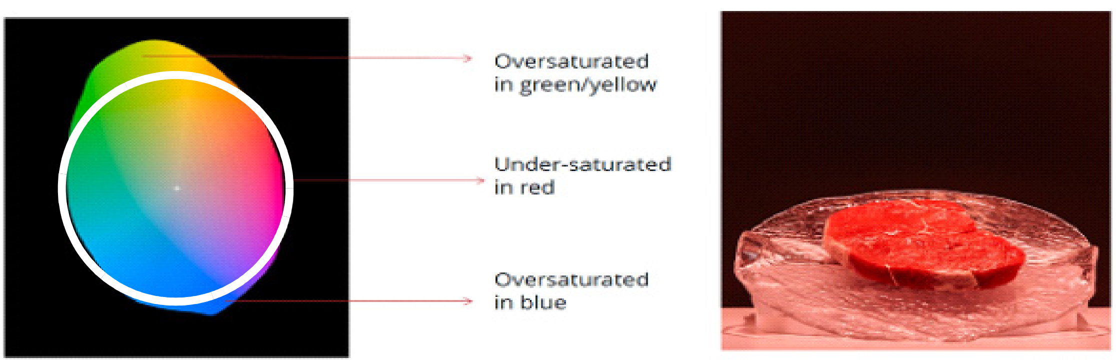
The information measured via TM-30-15 produces a color vector graphic that indicates average hue and chroma shifts, which helps with interpreting the values of Rf and Rg.



How does this apply to applications?

TM-30-15 seems to provide more information than CRI. Which TM-30-15 values are ideal for my application? The answer is, “it depends.” Like CRI, TM-30-15 is not prescriptive in defining metrics that would be ideal for a given application. Instead, it is a procedure for calculating and communicating color rendition.

The best way to ensure a light source works well in an application is to test it in the application. As an example, look at the graphic below.

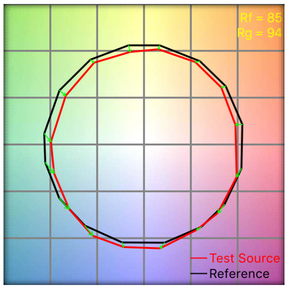


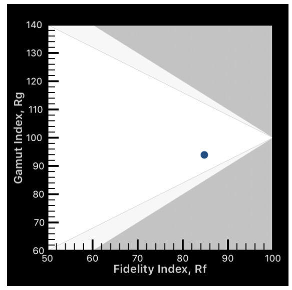
TM-30-15 seems to provide more information than CRI; but which TM-30-15 values are ideal for my application? The TM-30-15 color vector graphic on the left shows the relative saturation of different hues of the TM-30-15 color spectrum, which is shown illuminating beef. In this example, the beef looks ‘reddish’ to the eye. However, the color vector graphic indicates that the “red” spectrum is under-saturated in red and over-saturated in green and blue relative to the reference source—the very opposite of how the spectrum looks like to the human eye.

This is just an example of why TM-30-15 and CRI cannot predict values that would be ideal for a particular application. In addition, the TM-30-15 applies only to ‘nominally white’ sources and doesn’t work well with specialty color point.

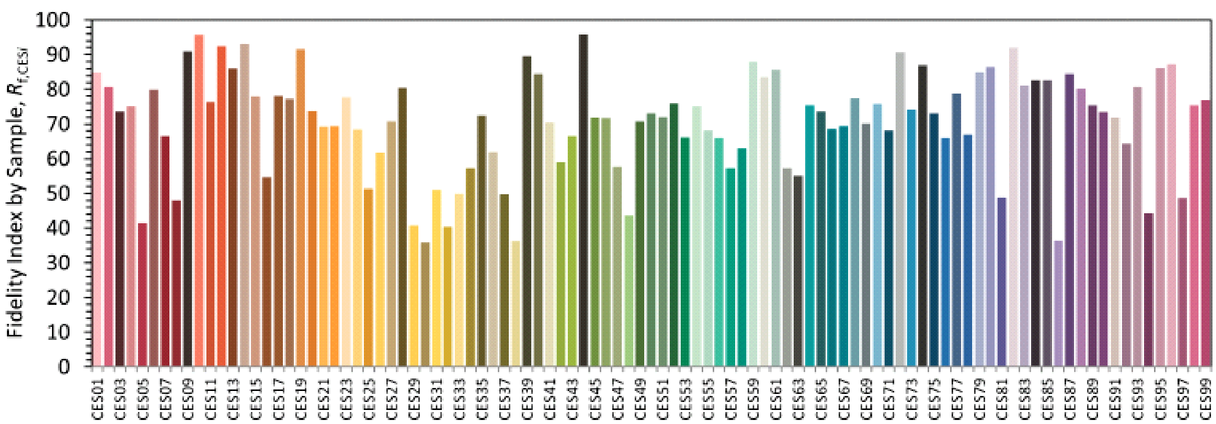
TM-30-15 vs. CRI The Takeaway

TM-30 is an improved color metric that will help to more accurately measure the color rendering of many light sources, especially LEDs. With more color samples, a more accurate assessment of color fidelity can be made. More color samples also suggests more detailed information about the rendition of specific objects. For example, CES 15 and CES 18 represent human skin tones. In an application where the color rendering of skin is important, the Rf, skin fidelity score (average of CES 15 and CES 18) can be calculated and can help with choosing the most appropriate light source. Below is a graph showing the fidelity scores of each individual sample for a given light source, as well as a graph showing color rendition by hue bin.





With CRI, the higher score was usually considered better. With TM-30, the best light source depends on what application it will be used in. TM-30 provides its users with enough detailed information to accurately make that decision. At the end of the day, TM-30 is a great tool that will tremendously help the lighting community with understanding and applying color rendering metrics.



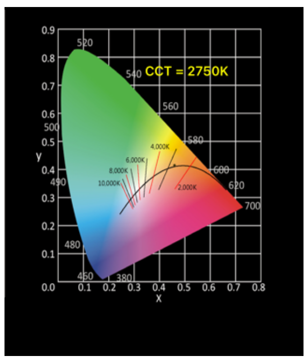
CDR70 / CDP70 LUMINAIRES PHOTOMETRICS

Refer to the product specification sheets for basic photometric information. The following is in addition to that information.

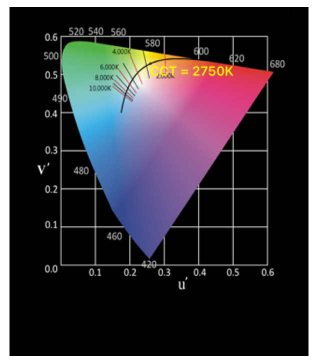
2700K TM-30 Information

Score Card 2700K	
CCT	2750
DUV	.0018
CRI	93
CQS	93
RE(R1-15)	90
TLCI (Qa)	94.2
TM-30-15 Rf	91
TM-30-15 Rg	98

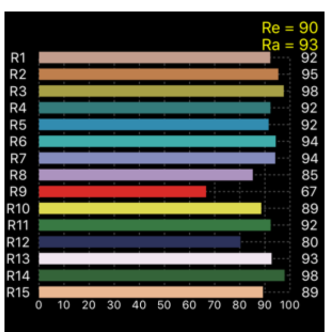
CIE 1931 Color Space



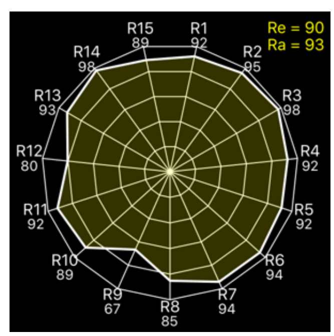
CIE 1976 LUV Color Space



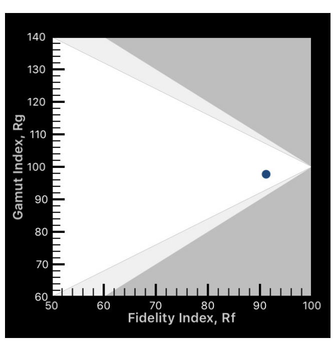
Histogram



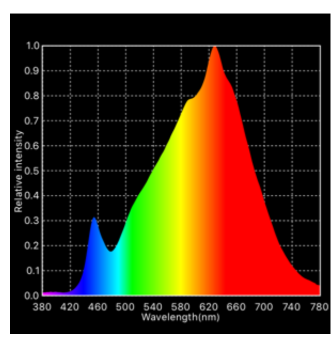
Plot / Radar



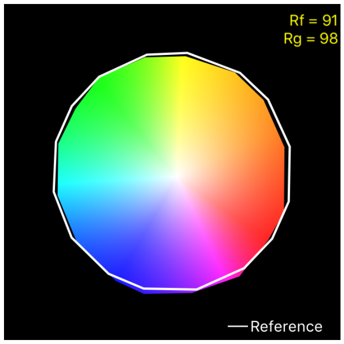
TM-30-15 Rf and Rg



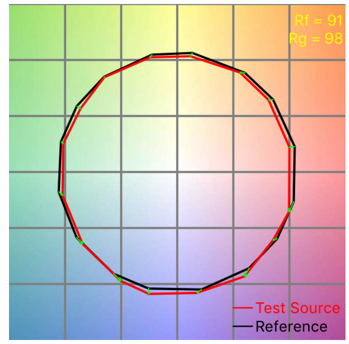
Spectrum



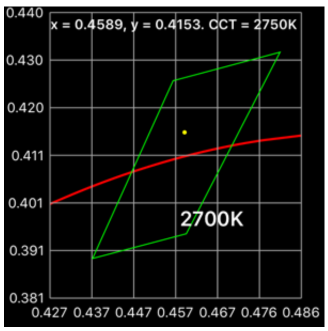
Color Distortion



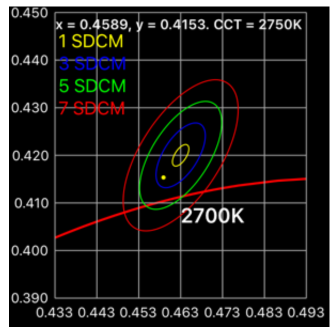
Color Vector



Chromaticity



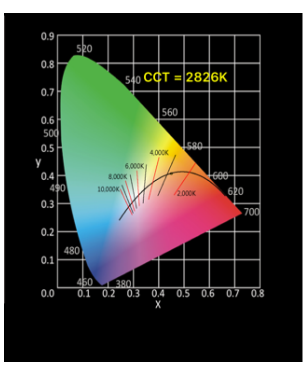
Color Matching / Consistency



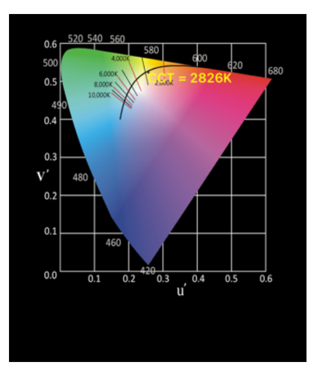
3000K TM-30 Information

Score Card 3000K	
CCT	2826
DUV	-.0033
CRI	91
CQS	91
RE(R1-15)	88
TLCI (Qa)	89.3
TM-30-15 Rf	90
TM-30-15 Rg	99

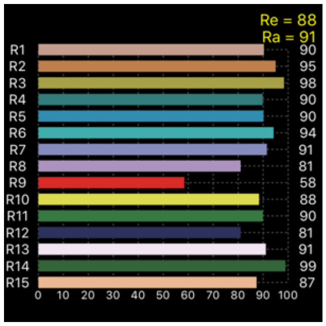
CIE 1931 Color Space



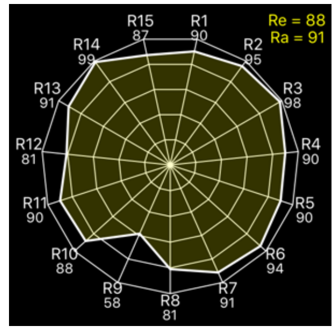
CIE 1976 LUV Color Space



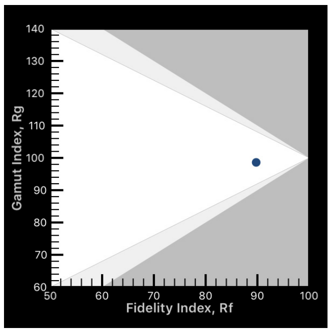
Histogram



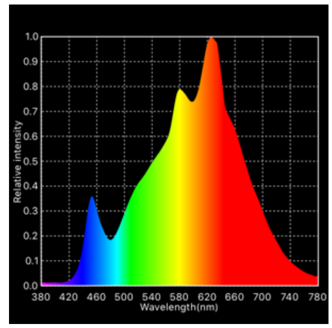
Plot / Radar



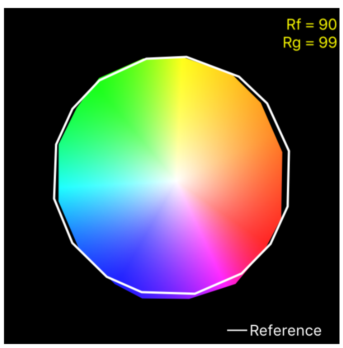
TM-30-15 Rf and Rg



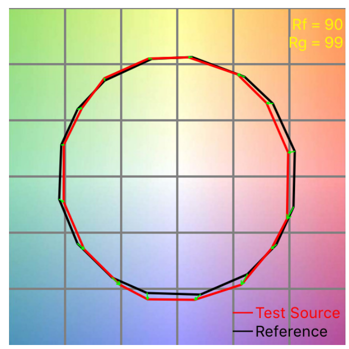
Spectrum



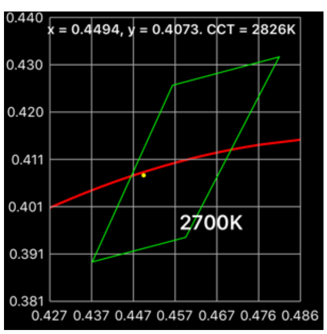
Color Distortion



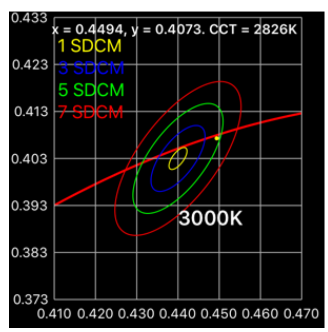
Color Vector



Chromaticity



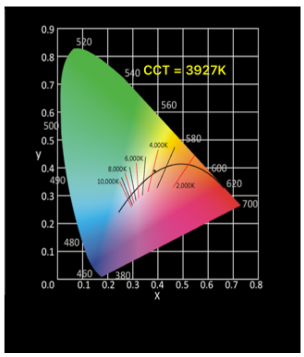
Color Matching / Consistency



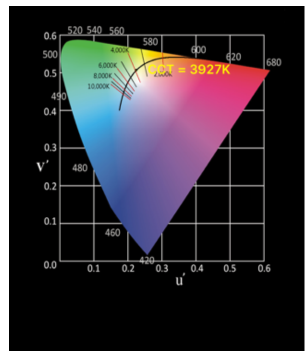
4000K TM-30 Information

Score Card 4000K	
CCT	3927
DUV	.0039
CRI	90
CQS	89
RE(R1-15)	85
TLCI (Qa)	91.6
TM-30-15 Rf	89
TM-30-15 Rg	98

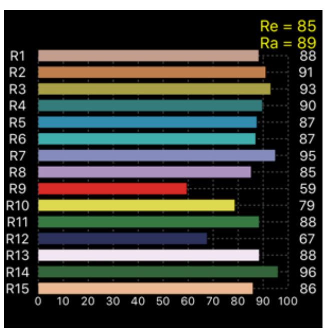
CIE 1931 Color Space



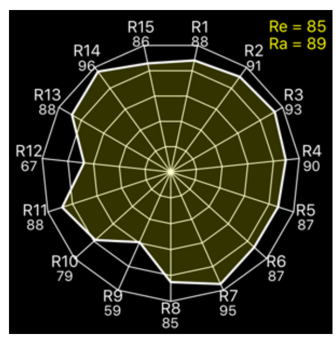
CIE 1976 LUV Color Space



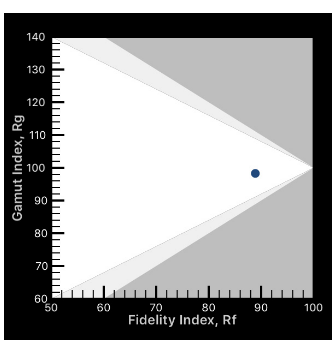
Histogram



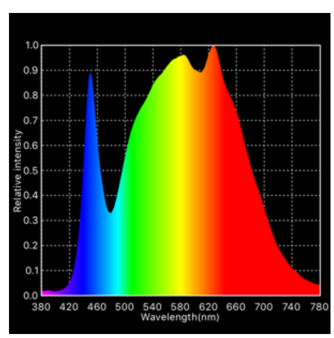
Plot / Radar



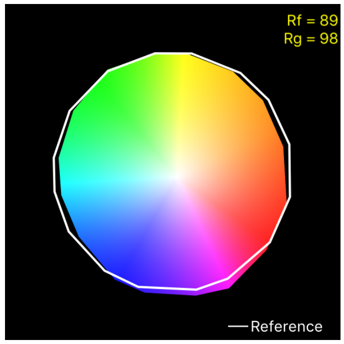
TM-30-15 Rf and Rg



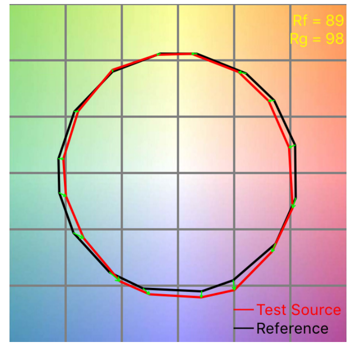
Spectrum



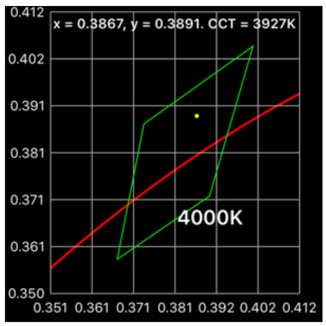
Color Distortion



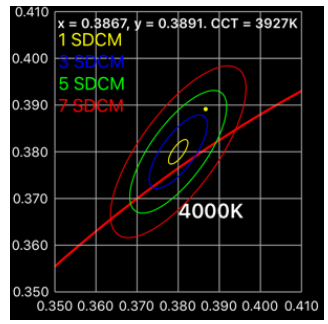
Color Vector



Chromaticity



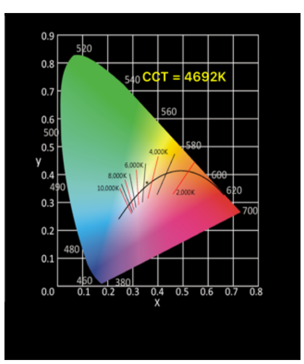
Color Matching / Consistency



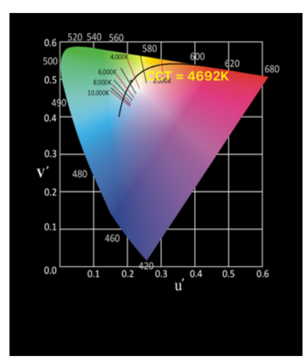
5000K TM-30 Information

Score Card 5000K	
CCT	4692
DUV	.0056
CRI	90
CQS	87
RE (R1-15)	84
TLCI (Qa)	89.8
TM-30-15 Rf	85
TM-30-15 Rg	94

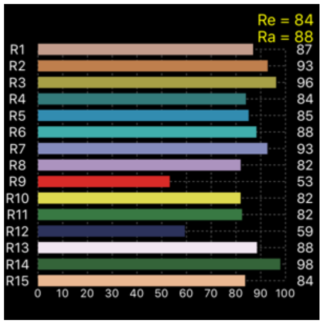
CIE 1931 Color Space



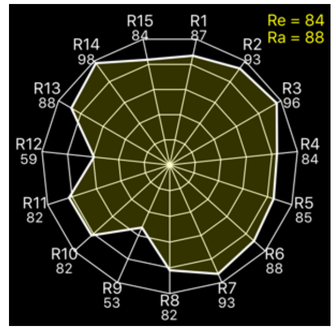
CIE 1976 LUV Color Space



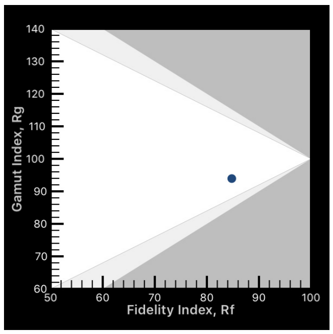
Histogram



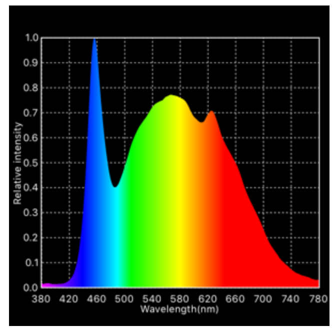
Plot / Radar



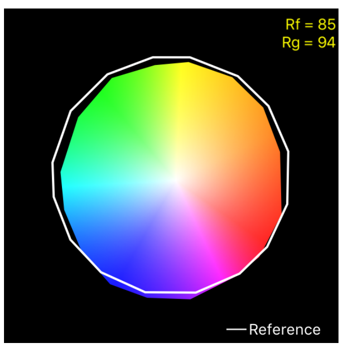
TM-30-15 Rf and Rg



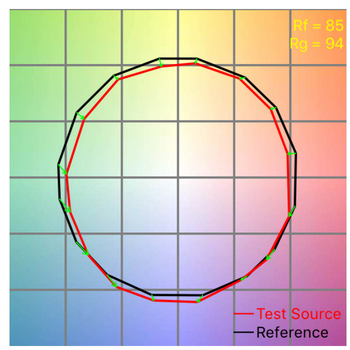
Spectrum



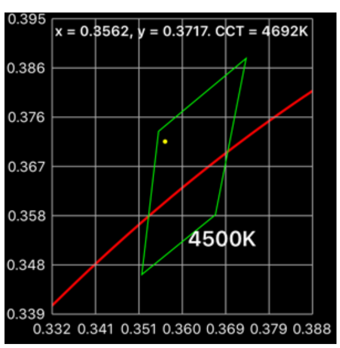
Color Distortion



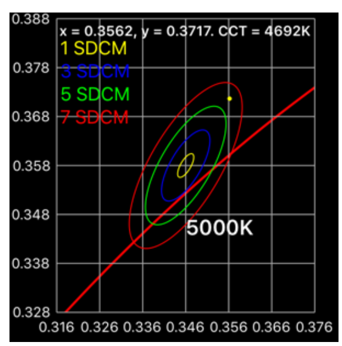
Color Vector



Chromaticity



Color Matching / Consistency



Photometric Performance (Foot Candles / Lux)

CCT	Reflector Type	Lumen Output	10'-0" (3.048m)	20'-0" (6.096m)	30'-0" (9.144m)	40'-0" (12.192m)	50'-0" (15.240m)	Units
5000K	20 Degree Narrow Spot	7016.0	554.3	138.6	61.6	8.7	3.8	fc
			5964.3	1491.1	662.7	93.2	41.4	lux
	29 Degree Spot	6204.0	198.2	49.6	22.0	3.1	1.4	fc
			2132.6	533.2	237.0	33.3	14.8	lux
	39 Degree Narrow Flood	6526.0	116.6	29.2	13.0	1.8	0.8	fc
			1254.6	313.7	139.4	19.6	8.7	lux
	46 Degree Medium Flood	6193.0	100.2	25.1	11.1	1.6	0.7	fc
			1078.2	269.5	119.8	16.8	7.5	lux
	51 Degree Wide Flood	6382.0	76.4	19.1	8.5	1.2	0.5	fc
			822.1	205.5	91.3	12.8	5.7	lux
	64 Degree Very Wide Flood	6429.0	58.3	14.6	6.5	0.9	0.4	fc
			627.1	156.8	69.7	9.8	4.4	lux
	91 Degree Extra Wide Flood	6079.0	36.5	9.1	4.1	0.6	0.3	fc
			393.2	98.3	43.7	6.1	2.7	lux
4000K	20 Degree Narrow Spot	7076.0	559.0	139.8	62.1	8.7	3.9	fc
			6014.8	1503.7	668.3	94.0	41.8	lux
	29 Degree Spot	6257.0	199.0	49.8	22.1	3.1	1.4	fc
			2141.2	535.3	237.9	33.5	14.9	lux
	39 Degree Narrow Flood	6582.0	117.6	29.4	13.1	1.8	0.8	fc
			1265.4	316.3	140.6	19.8	8.8	lux
	46 Degree Medium Flood	6246.0	99.2	24.8	11.0	1.6	0.7	fc
			1067.4	266.8	118.6	16.7	7.4	lux
	51 Degree Wide Flood	6436.0	77.1	19.3	8.6	1.2	0.5	fc
			829.6	207.4	92.2	13.0	5.8	lux
	64 Degree Very Wide Flood	6484.0	58.8	14.7	6.5	0.9	0.4	fc
			632.2	158.0	70.2	9.9	4.4	lux
	91 Degree Extra Wide Flood	6131.0	36.8	9.2	4.1	0.6	0.3	fc
			396.1	99.0	44.0	6.2	2.8	lux
3000K	20 Degree Narrow Spot	6032.0	476.6	119.2	53.0	7.4	3.3	fc
			5128.2	1282.1	569.8	80.1	35.6	lux
	29 Degree Spot	5334.0	170.4	42.6	18.9	2.7	1.2	fc
			1833.5	458.4	203.7	28.6	12.7	lux
	39 Degree Narrow Flood	5611.0	100.2	25.1	11.1	1.6	0.7	fc
			1078.2	269.5	119.8	16.8	7.5	lux
	46 Degree Medium Flood	5325.0	86.2	21.6	9.6	1.3	0.6	fc
			927.5	231.9	103.1	14.5	6.4	lux
	51 Degree Wide Flood	5486.0	65.7	16.4	7.3	1.0	0.5	fc
			706.9	176.7	78.5	11.0	4.9	lux
	64 Degree Very Wide Flood	5527.0	50.1	12.5	5.6	0.8	0.3	fc
			539.1	134.8	59.9	8.4	3.7	lux
	91 Degree Extra Wide Flood	5226.0	31.4	7.9	3.5	0.5	0.2	fc
			338.0	84.5	37.6	5.3	2.3	lux
2700K	20 Degree Narrow Spot	6084.0	480.7	120.2	53.4	7.5	3.3	fc
			5172.3	1293.1	574.7	80.8	35.9	lux
	29 Degree Spot	5380.0	171.9	43.0	19.1	2.7	1.2	fc
			1849.6	462.4	205.5	28.9	12.8	lux
	39 Degree Narrow Flood	5659.0	101.1	25.3	11.2	1.6	0.7	fc
			1087.8	272.0	120.9	17.0	7.6	lux
	46 Degree Medium Flood	5371.0	86.9	21.7	9.7	1.4	0.6	fc
			935.0	233.8	103.9	14.6	6.5	lux
	51 Degree Wide Flood	5534.0	66.3	16.6	7.4	1.0	0.5	fc
			713.4	178.3	79.3	11.1	5.0	lux
	64 Degree Very Wide Flood	5575.0	50.5	12.6	5.6	0.8	0.4	fc
			543.1	135.8	60.3	8.5	3.8	lux
	91 Degree Extra Wide Flood	5271.0	31.7	7.9	3.5	0.5	0.2	fc
			340.9	85.2	37.9	5.3	2.4	lux

ALTMAN Lighting

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