



## LM-79-08 Test Report

for

### GREEN CREATIVE LTD

756 North Zhongshan Rd., Unit B301 Zhabei District, Shanghai

### LED Downlight

**Model: 10DL6DIM/830**

### Laboratory: Leading Testing Laboratories

**NVLAP CODE: 200960-0**

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Report No.: HZ15100032e

The laboratory that conducted the testing detailed in this report has been accredited for SSL by NVLAP.

Review by:

Engineer: April Zou  
Nov. 02, 2015

Approved by:



Manager: Jim Zhang  
Nov. 02, 2015

Note: This report does not imply product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.

## Test Summary

Sample Tested: 10DL6DIM/830

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)	Power Factor
77.8	772.7	9.93	0.9274
CCT (K)	CRI	Stabilization Time (Light & Power)	
3086	82.5	65	

Table 1: Executive Data Summary

Note: The above results are recorded/ derived from measurements made using an Integrating Sphere.

### Test specifications:

<b>Date of Receipt</b>	: Oct. 14, 2015
<b>Date of Test</b>	: Oct. 27, 2015 to Oct. 30, 2015
<b>Test item</b>	: Total Luminous Flux, Luminous Distribution Intensity, Luminous Efficacy, Correlated Color Temperature, Color Rendering Index, Chromaticity Coordinate, Electrical parameters
<b>Reference Standard</b>	: IESNA LM-79-2008 Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products

## TABLE OF CONTENT

LM-79-08 Test Report.....	1
Test Summary.....	2
Sample Photo.....	4
TEST RESULTS .....	5
Goniophotometer Method .....	6
Spectral Power Distribution - Sphere Spectroradiometer Method .....	7
Chromaticity Diagram - Sphere Spectroradiometer Method.....	8
Nominal CCT Quadrangles – Sphere Spectroradiometer Method .....	9
Zonal Lumen Tabulation- Goniophotometer Method .....	10
Illuminance Plots- Goniophotometer Method .....	11
Luminous Intensity Distribution Plots- Goniophotometer Method.....	13
Luminous Intensity Data- Goniophotometer Method.....	14
EQUIPMENT LIST .....	16
TEST METHODS .....	16
Seasoning of SSL Product.....	16
Sphere-Spectroradiometer Method- Photometric and Electrical Measurements.....	16
Goniophotometer Method .....	17
Photometric and Electrical Measurements.....	17
Color Characteristics Measurements.....	17
Color Spatial Uniformity .....	17

## Sample Photo



Figure 1- Overview of the sample

### Equipment Under Test (EUT)

<b>Name</b>	: LED Downlight
<b>Model</b>	: 10DL6DIM/830
<b>Electrical Ratings</b>	: 120Vac, 60Hz, 10W
<b>Product Description</b>	: E26 base, 3000K, Frosted lens
<b>Manufacturer</b>	: GREEN CREATIVE LTD
<b>Address</b>	: 756 North Zhongshan Rd., Unit B301 Zhabei District, Shanghai

## TEST RESULTS

Test ambient temperature was 25.1 °C.

Base orientation was base up. Test was conducted without a dimmer in the circuit.

The stabilization time of the sample was 65 minutes, and the total operating time including stabilization was 70 minutes.

### Sphere-Spectroradiometer Method

Parameter	Result
Test Voltage (V)	120.0
Voltage frequency (Hz)	60
Test Current (A)	0.089
Power Factor	0.9274
Test Power (W)	9.93
Luminous Efficacy (lm/W)	77.8
THD A%	32.51
Total Luminous Flux (lm)	772.7
Color Rendering Index (CRI)	82.5
R9	9
Correlated Color Temperature (CCT) (K)	3086
Chromaticity Chroma x	0.4309
Chromaticity Chroma y	0.4021
Chromaticity Chroma u	0.2475
Chromaticity Chroma v	0.3465
Duv	0.0005
Chromaticity Chroma u'	0.2475
Chromaticity Chroma v'	0.5197

Special Color Rendering Indices	
R1	80.4
R2	89.3
R3	96.6
R4	81.2
R5	80.7
R6	86.6
R7	84
R8	60.9
R9	9
R10	75.8
R11	80.4
R12	72.1
R13	82.2
R14	98.2

Table 2: Test data per Sphere-Spectroradiometer Method

Note: According to CIE 1976 (u',v') diagram,  $u' = u = 4x/(-2x+12y+3)$ ,  $v' = 3v/2 = 9y/(-2x+12y+3)$ .

## Goniophotometer Method

Test ambient temperature was 24.8°C.

The photometric distance is 2.475m.

Luminous data was taken at 0.5°vertical intervals and 10°horizontal intervals.

Parameter	Result
Test Voltage (V)	120.0
Voltage frequency (Hz)	60
Test Current (A)	0.089
Power Factor	0.9301
Test Power (W)	9.94
Luminous Efficacy (lm/W)	77.3
Total Luminous Flux (lm)	768.1
Beam Angle (°)	96.9
Center Beam Candle Power (cd)	337
Spacing Criteria	1.19 (0°-180°)/ 1.19 (90°-270°)
Zonal Lumens in the 0°-60°Zone	86.56%
Zonal Lumens in the 60°-90°Zone	13.34%
Zonal Lumens in the 90°-120°Zone	0.02%
Zonal Lumens in the 120°-180°Zone	0.08%

Table 3: Test data per Goniophotometer Method

## Spectral Power Distribution - Sphere Spectroradiometer Method

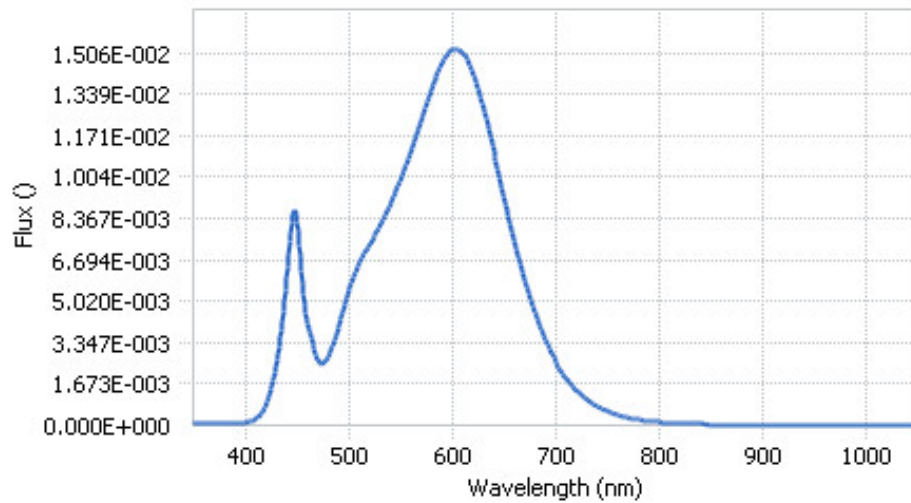
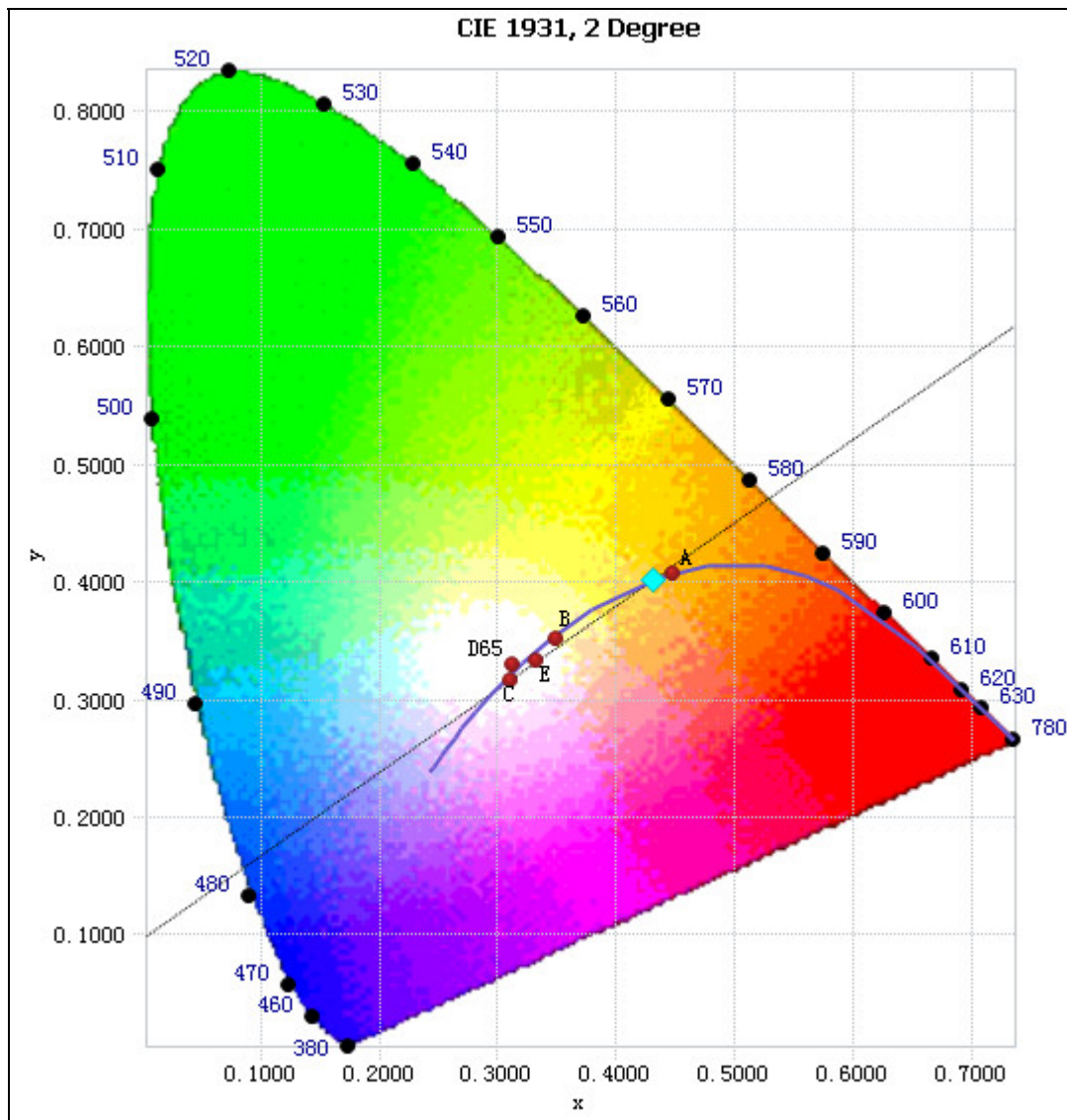


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	9.63E-05	485	3.25E-03	590	1.47E-02	695	2.94E-03
385	8.26E-05	490	3.93E-03	595	1.50E-02	700	2.55E-03
390	9.23E-05	495	4.73E-03	600	1.52E-02	705	2.20E-03
395	9.19E-05	500	5.46E-03	605	1.52E-02	710	1.89E-03
400	1.17E-04	505	6.07E-03	610	1.50E-02	715	1.62E-03
405	1.61E-04	510	6.55E-03	615	1.48E-02	720	1.40E-03
410	2.34E-04	515	7.00E-03	620	1.42E-02	725	1.21E-03
415	4.14E-04	520	7.33E-03	625	1.36E-02	730	1.03E-03
420	7.89E-04	525	7.67E-03	630	1.28E-02	735	8.79E-04
425	1.42E-03	530	8.05E-03	635	1.20E-02	740	7.54E-04
430	2.41E-03	535	8.48E-03	640	1.11E-02	745	6.44E-04
435	3.88E-03	540	8.92E-03	645	1.01E-02	750	5.53E-04
440	5.95E-03	545	9.41E-03	650	9.20E-03	755	4.78E-04
445	8.20E-03	550	9.91E-03	655	8.30E-03	760	4.08E-04
450	8.22E-03	555	1.05E-02	660	7.41E-03	765	3.54E-04
455	5.70E-03	560	1.11E-02	665	6.62E-03	770	3.02E-04
460	4.10E-03	565	1.17E-02	670	5.84E-03	775	2.62E-04
465	3.32E-03	570	1.24E-02	675	5.13E-03	780	2.28E-04
470	2.68E-03	575	1.30E-02	680	4.52E-03		
475	2.49E-03	580	1.36E-02	685	3.92E-03		
480	2.74E-03	585	1.42E-02	690	3.41E-03		

Table 4: Spectral Power Distribution Numerical Data per Sphere - Spectroradiometer Method

## Chromaticity Diagram - Sphere Spectroradiometer Method



Tristimulus values(x, y): (0.4309, 0.4021)

Chart 2: Chromaticity Diagram per Sphere - Spectroradiometer Method

Note: The location on the diagram of the tristimulus coordinates are indicated by the blue diamond.



### Nominal CCT Quadrangles – Sphere Spectroradiometer Method

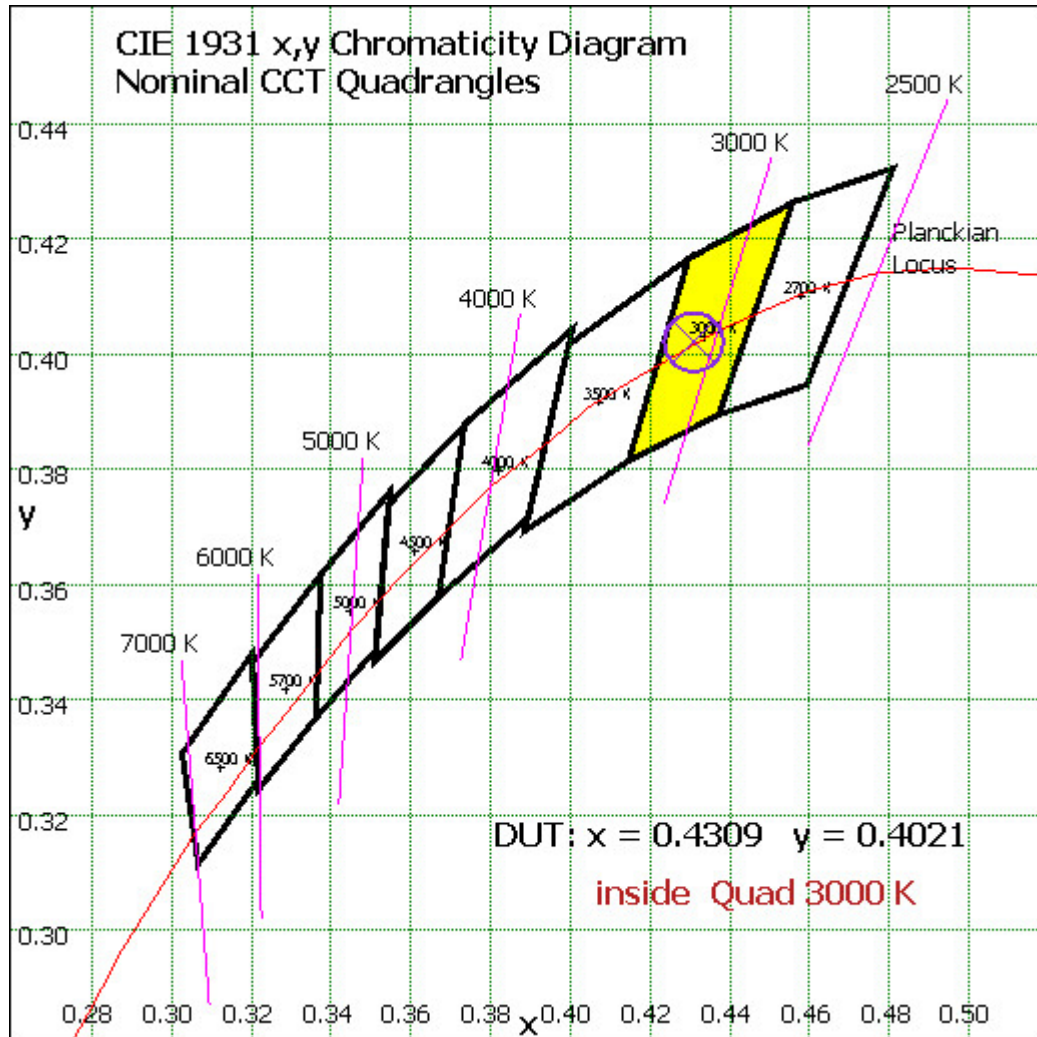


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

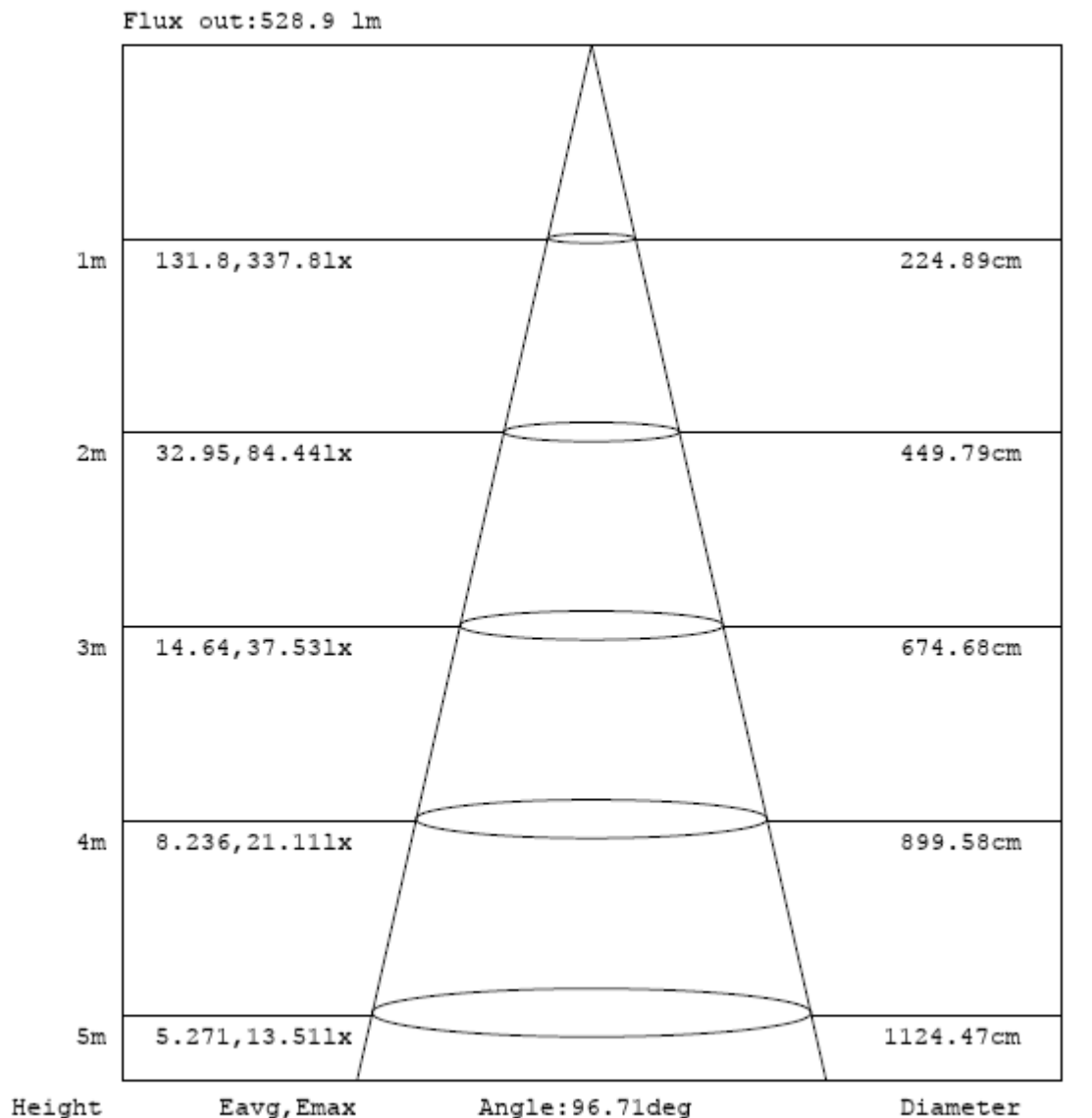
### Zonal Lumen Tabulation- Goniophotometer Method

$\gamma(^{\circ})$	Lumens	% Total
0- 10	31.815	4.14%
10- 20	89.72	11.68%
20- 30	131.527	17.12%
30- 40	150.803	19.63%
40- 50	145.492	18.94%
50- 60	115.549	15.04%
60- 70	70.833	9.22%
70- 80	26.8	3.49%
80- 90	4.82	0.63%
90-100	0.042	0.01%
100-110	0.064	0.01%
110-120	0.082	0.01%
120-130	0.1	0.01%
130-140	0.123	0.02%
140-150	0.135	0.02%
150-160	0.12	0.02%
160-170	0.082	0.01%
170-180	0.031	0.00%
Total	768.1	100%

$\gamma(^{\circ})$	Lumens	% Total
0- 60	664.906	86.56%
60- 90	102.453	13.34%
0-90	767.359	99.90%
90- 180	0.779	0.10%
0- 180	768.1	100%

Table 5: Zonal Lumen Data

## Illuminance Plots- Goniophotometer Method



Note: The Curves indicate the illuminated area and the average illumination when the luminaire is at different distance.

Chart 4: Beam Angle

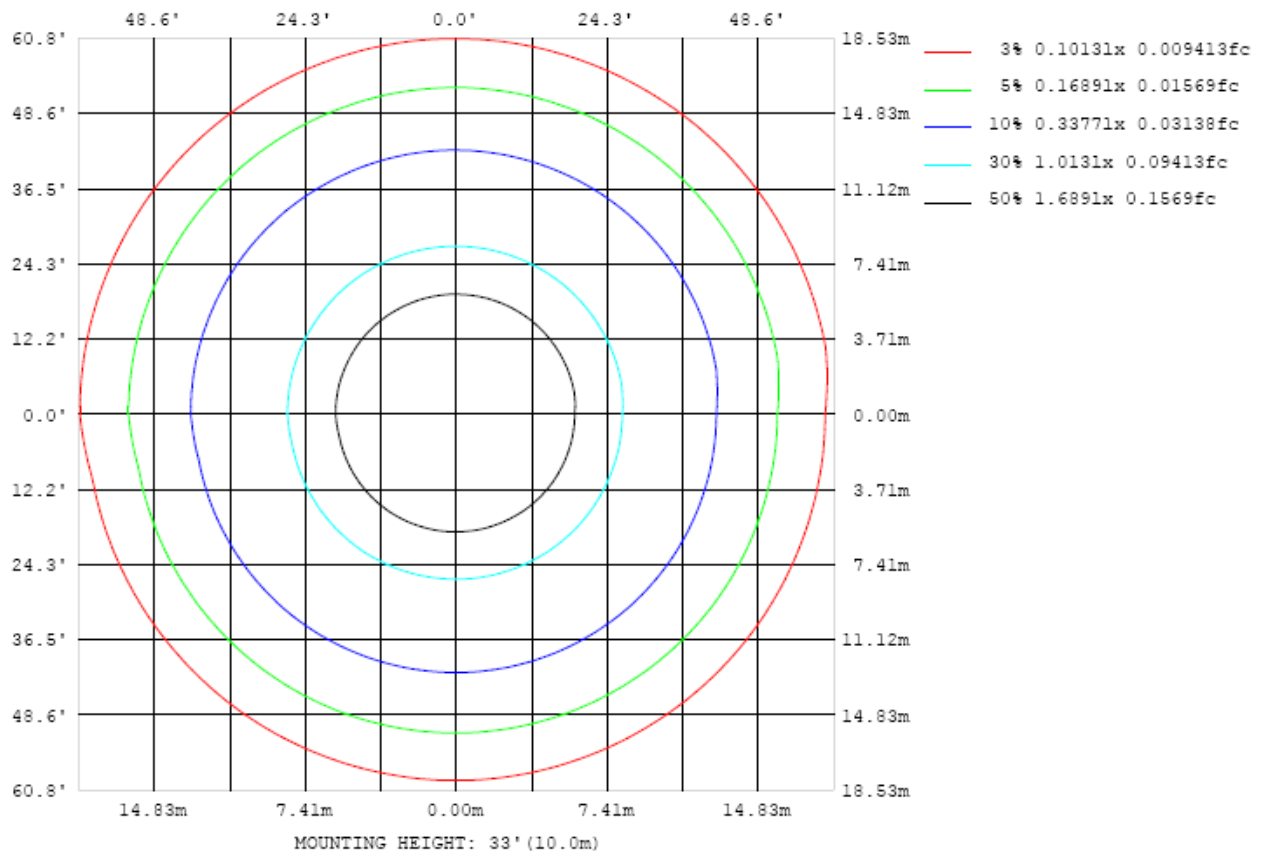


Chart 5: Illuminance Plot (Footcandles)

## Luminous Intensity Distribution Plots- Goniophotometer Method

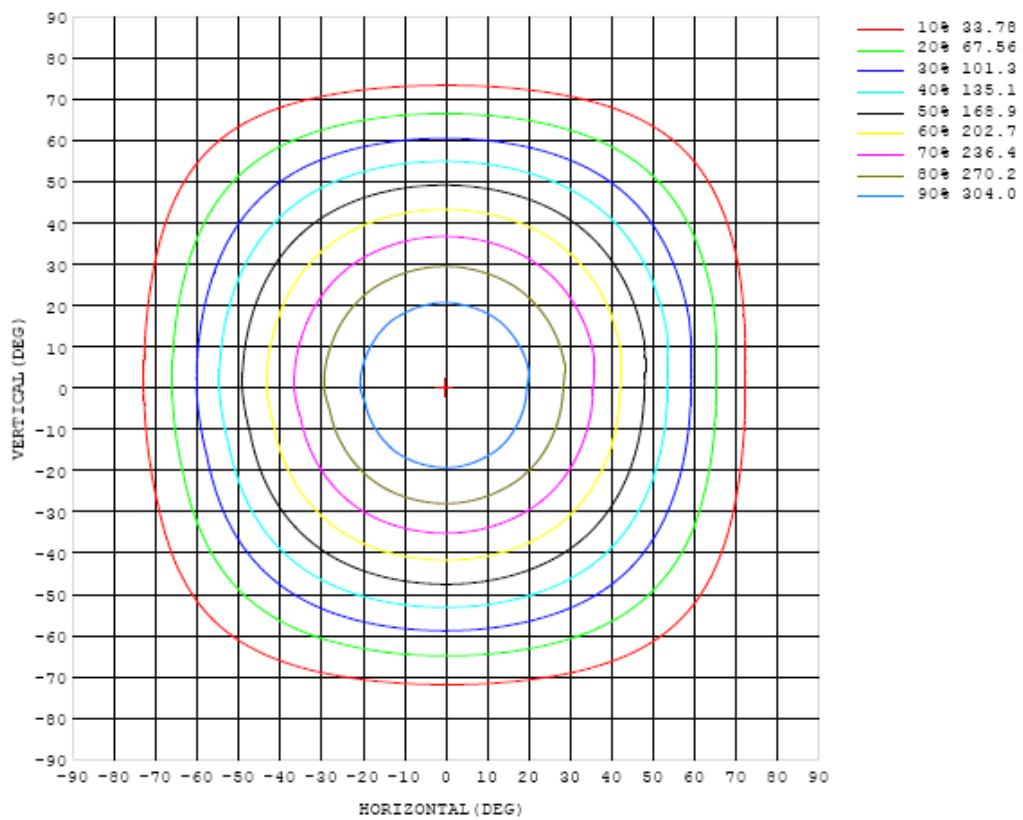


Chart 6: Isocandela Plot

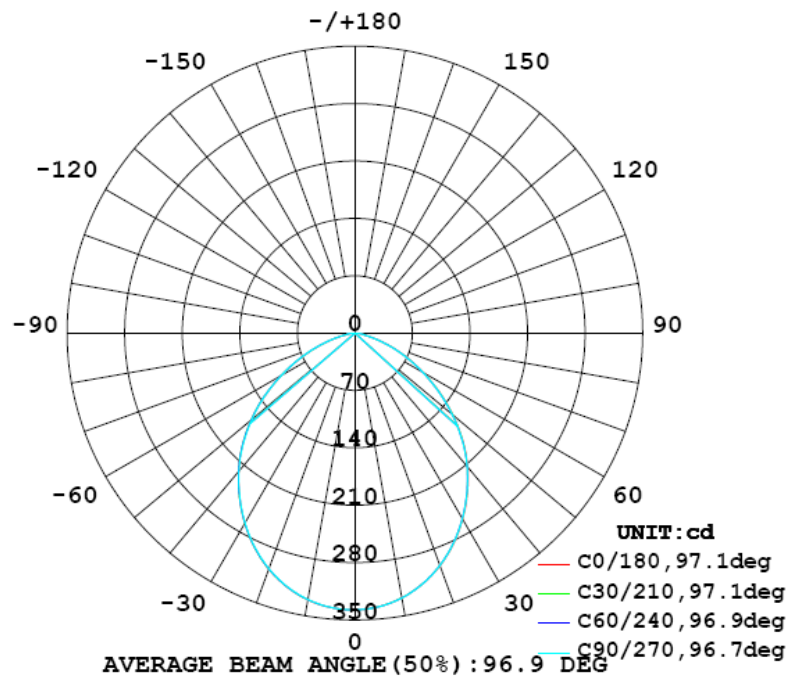


Chart 7: Polar Candela Distribution

## Luminous Intensity Data- Goniophotometer Method

Table--1

UNIT: cd

C (DEG) y (DEG)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
0	337	337	337	337	337	337	337	337	337	337	337	337	337	337	337	337	337	337	337
5	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	335	336
10	328	328	328	328	328	328	328	328	328	328	328	328	328	328	329	329	329	329	330
15	317	317	317	317	317	317	317	317	317	317	317	317	317	318	318	318	318	318	320
20	302	302	302	302	302	302	302	302	302	302	302	302	302	303	303	303	303	303	306
25	284	283	283	283	283	283	283	283	283	283	283	284	284	284	284	285	285	285	289
30	262	262	262	261	261	261	261	261	261	261	262	262	262	263	263	263	264	264	268
35	238	238	238	238	238	237	237	237	237	237	238	238	239	239	239	240	240	240	245
40	213	213	213	213	212	212	212	212	212	212	213	213	214	214	214	215	215	215	220
45	186	185	185	185	185	185	184	184	184	184	185	185	185	186	187	187	188	188	193
50	156	155	155	155	155	155	154	154	154	154	155	155	156	156	157	157	158	158	164
55	125	125	125	125	124	124	124	124	124	124	125	125	125	126	126	127	127	127	134
60	95.8	95.7	95.4	95.3	95.0	94.8	94.7	94.6	94.6	94.8	95.0	95.1	95.3	95.6	95.8	96.1	96.5	96.7	103
65	68.1	68.6	69.1	68.0	67.8	67.6	67.5	67.4	67.3	67.2	67.3	67.3	67.3	67.5	67.7	67.9	68.2	69.3	74.2
70	43.8	43.6	43.5	43.3	43.2	42.9	42.7	42.6	42.5	42.4	42.4	42.4	42.5	42.6	42.7	42.9	43.1	43.3	47.9
75	22.7	22.6	22.5	22.3	22.2	22.0	21.9	21.8	21.8	21.7	21.7	21.7	21.7	21.7	21.8	21.9	22.0	22.2	25.7
80	9.40	9.35	9.33	9.28	9.26	9.21	9.19	9.16	9.16	9.14	9.11	9.12	9.10	9.12	9.12	9.16	9.17	9.17	10.7
85	3.82	3.80	3.76	3.75	3.72	3.70	3.67	3.65	3.63	3.59	3.51	3.47	3.45	3.45	3.49	3.55	3.56	3.55	4.74
90	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.05
95	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.05
100	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.07
105	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.08
110	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.09
115	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.09
120	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.10
125	0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.11	0.11
130	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.13
135	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
140	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
145	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.22
150	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.25
155	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.28
160	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.29
165	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.31
170	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.33
175	0.32	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
180	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.34	0.34	0.33	0.34	0.34	0.34	0.34	0.33	0.34	0.34	0.33	0.33

Table 6: Luminous Intensity Data

Table--2

UNIT: cd

C (DEG) y (DEG)	190	200	210	220	230	240	250	260	270	280	290	300	310	320	330	340	350		
0	337	337	337	337	337	337	337	337	337	337	337	337	337	337	337	337	337		
5	336	336	336	336	336	336	336	336	336	336	336	336	336	336	336	336	336		
10	330	330	330	330	330	330	330	330	330	330	330	330	330	330	330	329	330		
15	320	320	320	320	320	320	320	320	320	320	320	320	319	320	319	319	319		
20	306	307	306	306	306	306	306	306	306	306	306	306	305	305	305	305	305		
25	289	289	289	289	289	289	288	288	288	288	288	288	288	288	287	287	287		
30	268	268	268	268	268	268	268	267	267	267	267	267	267	267	267	266	266		
35	245	245	245	245	245	245	245	244	244	244	244	244	244	244	243	243	243		
40	220	220	220	220	220	220	220	220	220	220	219	219	219	219	219	219	218		
45	194	194	194	194	194	194	193	193	193	192	192	192	192	192	191	191	191		
50	165	165	165	165	165	165	164	164	163	163	163	162	162	162	162	162	161		
55	135	135	135	135	135	135	135	134	134	134	133	133	132	132	132	132	132		
60	104	104	104	104	104	104	104	104	104	104	103	103	103	103	102	102	102		
65	74.5	74.7	74.8	75.0	75.1	75.2	75.2	75.2	75.1	75.0	74.8	74.7	74.6	74.5	74.4	74.2	74.1		
70	48.1	48.3	48.6	48.7	48.8	48.9	48.9	49.0	48.9	48.9	48.7	48.7	48.7	48.6	48.5	48.3	48.3		
75	25.9	26.1	26.2	26.4	26.5	26.6	26.6	26.7	26.7	26.7	26.6	26.6	26.5	26.5	26.4	26.3	26.2		
80	10.8	10.8	10.9	11.0	11.1	11.2	11.2	11.3	11.3	11.3	11.3	11.3	11.2	11.2	11.1	11.1	11.1		
85	4.78	4.79	4.82	4.86	4.92	4.97	5.02	5.07	5.07	5.06	5.04	5.03	5.03	5.03	5.04	5.01	4.98		
90	0.06	0.06	0.06	0.07	0.07	0.08	0.09	0.10	0.11	0.12	0.14	0.15	0.17	0.19	0.20	0.22	0.23		
95	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05		
100	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.06	0.07	0.07		
105	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08		
110	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09		
115	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.10	0.09	0.09	0.09	0.10	0.10	0.10		
120	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10		
125	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11		
130	0.13	0.12	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13		
135	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16		
140	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19		
145	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.23		
150	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.26	0.26	0.25	0.25	0.26	0.25		
155	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28		
160	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29		
165	0.30	0.30	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31		
170	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33		
175	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33		
180	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.34	0.33	0.33	0.34	0.34	0.33	0.33	0.33	0.34	0.33		

Table 7: Luminous Intensity Data



## EQUIPMENT LIST

Test Equipment	Model	Equipment No.	Calibration Date	Calibration Due date
Goniophotometer system	GO-R5000	HZTE011-01	Jul. 17, 2015	Jul. 16, 2016
Digital Power Meter	PF2010A	HZTE028-01	Jul. 17, 2015	Jul. 16, 2016
AC Power Supply	PCR 500L	HZTE001-08	Jul. 17, 2015	Jul. 16, 2016
DC Power Supply	WY12010	HZTE004-03	Jul. 17, 2015	Jul. 16, 2016
Temperature Meter	TES1310	HZTE017-01	Jul. 17, 2015	Jul. 16, 2016
Standard source	D908	HZTE012-01	Jul. 23, 2015	Jul. 22, 2016
Integrate Sphere system	2M	HZTE015-01	Jul. 16, 2015	Jul. 15, 2016
Digital Power Meter	WT210	HZTE008-01	Jul. 17, 2015	Jul. 16, 2016
AC Power Supply	PCR 500L	HZTE001-07	Jul. 17, 2015	Jul. 16, 2016
DC Power Supply	6154	HZTE004-04	Jul. 17, 2015	Jul. 16, 2016
Temperature and humidity recorder	JR900	HZTE018-01	Jul. 21, 2015	Jul. 20, 2016
Standard source	SCL-1400	HZTE012-02	Oct. 21, 2015	Oct. 20, 2016

Table 8: Test Equipment List

## TEST METHODS

### Seasoning of SSL Product

For the purpose of rating new SSL products, SSL products shall be tested with no seasoning. Therefore, no seasoning was performed.

### Sphere-Spectroradiometer Method- Photometric and Electrical Measurements

A Labsphere Model CDS 2100 Spectroradiometer and Two Meter Sphere was used to measure correlated color temperature, chromaticity coordinates, and the color rendering index for each SSL unit. The coating reflectance of each sphere is 98%. The measure geometry is  $4\pi$ . Self-absorption correction is conducted in testing. Bandwidth of spectroradiometer is 350nm-1050nm.

Ambient temperature was measured at a position inside the sphere. Each SSL unit was operated on the client provided driver at the rated input voltage in its designated orientation.

The stabilization time typically ranges from 30 min (small integrated LED lamps) to 2 or more hours for large SSL luminaires). It can be judged that stability is reached when the variation (maximum – minimum) of at least 3 readings of the light output and electrical power over a period of 30 min, taken 15 minutes apart, is less than 0.5 %.

Electrical measurements including voltage, current, and power were measured using the Yokogawa Power Analyzer.

The standard reference of the integrated sphere system is halogen incandescent lamp, the intensity distribution type is omni-directional, and is traceable to the National Institute of Standards and Technology.

The uncertainty of integrating sphere system reported in this document is expanded uncertainty is 1.06% with a coverage factor  $k=2$ .



## **Goniophotometer Method**

### **Photometric and Electrical Measurements**

An EVERFINE Type C Model GO-R5000 Goniophotometer was used to measure the intensity at each angle of distribution for each sample. The photometric distance is 2.475m for near-field measurement or 30m for far-field measurement. Bandwidth of spectroradiometer is 380nm-780nm.

Ambient temperature was measured at the same height of the sample mounted on the Goniophotometer equipment. Each SSL unit was operated on the client provided driver at the rated input voltage in its designated orientation.

The stabilization time typically ranges from 30 min (small integrated LED lamps) to 2 or more hours for large SSL luminaires). It can be judged that stability is reached when the variation (maximum – minimum) of at least 3 readings of the light output and electrical power over a period of 30 min, taken 15 minutes apart, is less than 0.5 %.

Electrical measurements including voltage, current, and power were measured using the Everfine Digital Power Meter.

Some graphics were created with Photometric Plus software.

The standard reference of the Goniophotometer system is halogen incandescent lamp, the intensity distribution type is omni-directional, and is traceable to the National Institute of Metrology P.R. China.

The uncertainty of goniophotometer system reported in this document is expanded uncertainty is 1.94% with a coverage factor  $k=2$ .

### **Color Characteristics Measurements**

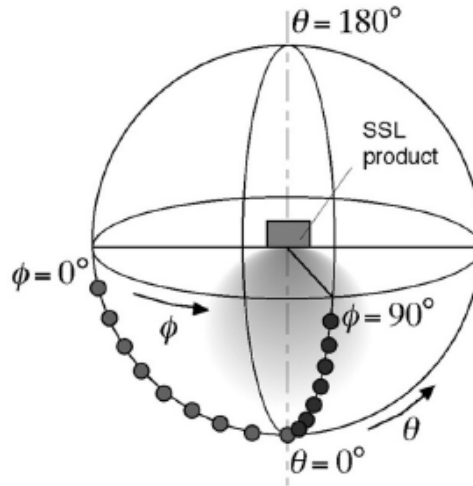
The color characteristics of SSL products include chromaticity coordinates, correlated color temperature, and color rendering index. These characteristics of SSL products may be spatially non-uniform, and thus, in order that they can be specified accurately, the color quantities shall be measured as values that are spatially average, weighted to intensity, over the angular range where light is intentionally emitted from the SSL product. The color characteristics measurements are using gonio-spectroradiometer.

### **Color Spatial Uniformity**

The characteristics of SSL products may be spatially non-uniform, the chromaticity coordinate shall be measured at two vertical planes ( $C=0^\circ/180^\circ$  and  $C=90^\circ/270^\circ$ ) and at  $10^\circ$  or less intervals for vertical angle until the light output dropped to below 10% of the peak intensity. The averaged weighted chromaticity coordinate was calculated from these points. The data was then analyzed to check for delta color differences of the  $u'$ ,  $v'$  chromaticity coordinates. The spatial non-uniformity of chromaticity,  $\Delta u'v'$ , is determined as the maximum deviation (distance on the CIE ( $u'$ ,  $v'$ ) diagram) among all measured points from the spatially averaged

chromaticity coordinate.

The geometry for the chromaticity measurement using gonio-spectroradiometer is shown as following.



\*\*\* End of Report \*\*\*

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