



LM-79-08 Test Report

for

Revolution Lighting Technologies, Inc.

2280 Ward Ave. Simi Valley, CA 93065

LED Tube

Model: 203101-112

Laboratory: Leading Testing Laboratories

NVLAP CODE: 200960-0

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Report No.: HZ18110016aq

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

Review by:

Engineer: April Zou
Nov. 30, 2018

Approved by:



Manager: Jim Zhang
Nov. 30, 2018

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: 203101-112

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)	Power Factor
124.9	1772.0	14.19	0.9805
CCT (K)	CRI	Stabilization Time (Light & Power)	
3459	81.7	60	

Table 1: Executive Data Summary

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

Test specifications:

Date of Receipt : Nov. 12, 2018

Date of Test : Nov. 13, 2018

Test item : Total Luminous Flux, Luminous Distribution Intensity, Luminous Efficacy, Correlated Color Temperature, Color Rendering Index, Chromaticity Coordinate, Electrical parameters

Reference Standard : IESNA LM-79-2008 Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products

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Sample Photo

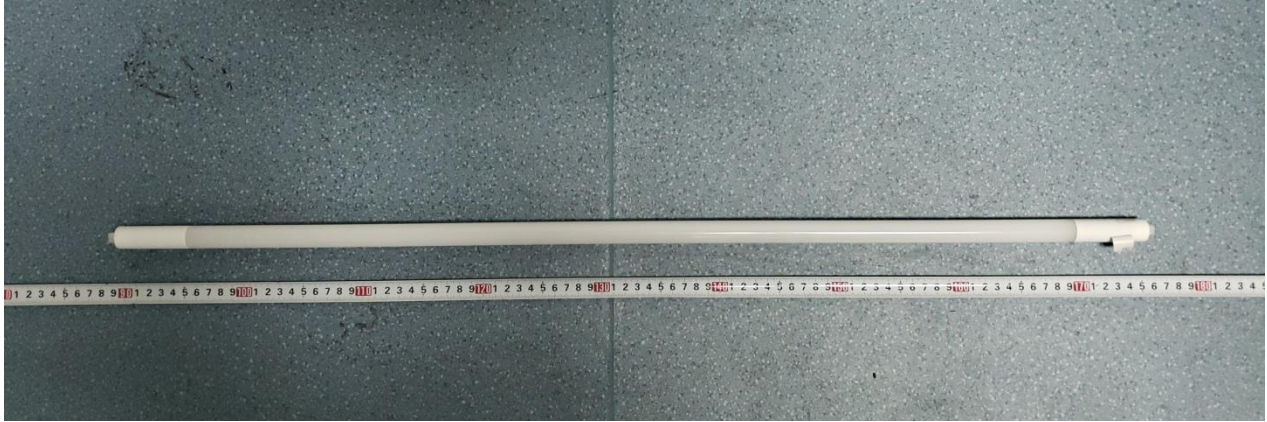


Figure 1- Overview of the sample

Equipment Under Test (EUT)

Name	: LED Tube
Model	: 203101-112
Electrical Ratings	: 120-277V, 60Hz
Product Description	: 3500K
Manufacturer	: Revolution Lighting Technologies, Inc.
Address	: 2280 Ward Ave. Simi Valley, CA 93065

TEST RESULTS

Test ambient temperature was 25.0°C.

Base orientation was Light down. Test was conducted without a dimmer in the circuit.

The stabilization time of the sample was 60 minutes, and the total operating time including stabilization was 65 minutes.

Sphere-Spectroradiometer Method

Parameter	Result	
	Test Voltage (V)	120.0
Voltage frequency (Hz)	60	60
Test Current (A)	0.121	0.056
Power Factor	0.9805	0.9520
Test Power (W)	14.19	14.65
THD A%	18.99	22.04
Luminous Efficacy (lm/W)	124.9	121.6
Total Luminous Flux (lm)	1772.0	1781.0
Color Rendering Index (CRI)	81.7	
R9	0.7	
Correlated Color Temperature (CCT)(K)	3459	
Chromaticity Chroma x	0.4077	
Chromaticity Chroma y	0.3923	
Chromaticity Chroma u	0.2366	
Chromaticity Chroma v	0.3415	
Duv	0.0001	
Chromaticity Chroma u'	0.2366	
Chromaticity Chroma v'	0.5123	

Special Color Rendering Indices	
R1	79.7
R2	89.9
R3	96
R4	79.5
R5	80
R6	86.8
R7	83.1
R8	58.7
R9	0.7
R10	76.6
R11	78.4
R12	66.3
R13	82.2
R14	98.3

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 25.1 °C.

The photometric distance is 30 m.

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)	0.121
Power Factor	0.9802
Power (W)	14.25
Luminous Efficacy (lm/W)	124.3
Total Luminous Flux (lm)	1771.9
Beam Angle (°)	103.9 (0°-180°) /127.6(90°-270°)
Center Beam Candle Power (cd)	504
Maximum Beam Candle Power (cd)	507.0 (At: C=180.0, Gamma=1.5)
Spacing Criteria	1.23 (0°-180°) /1.30 (90°-270°)
Zonal Lumens in the 0 °-60 °Zone	64.68%
Zonal Lumens in the 60 °-90 °Zone	25.38%
Zonal Lumens in the 90 °-120 °Zone	7.54%
Zonal Lumens in the 120 °-180 °Zone	2.41%

Table 3: Test data per Goniophotometer Method

Spectral Power Distribution - Sphere Spectroradiometer Method

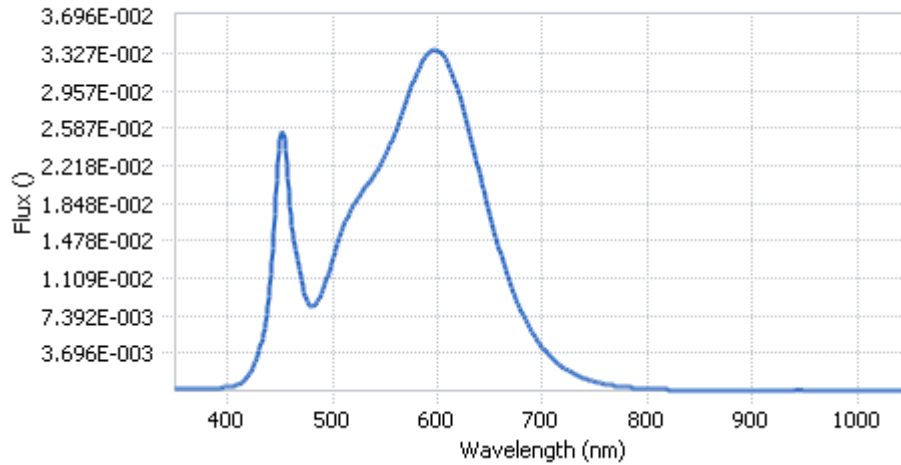
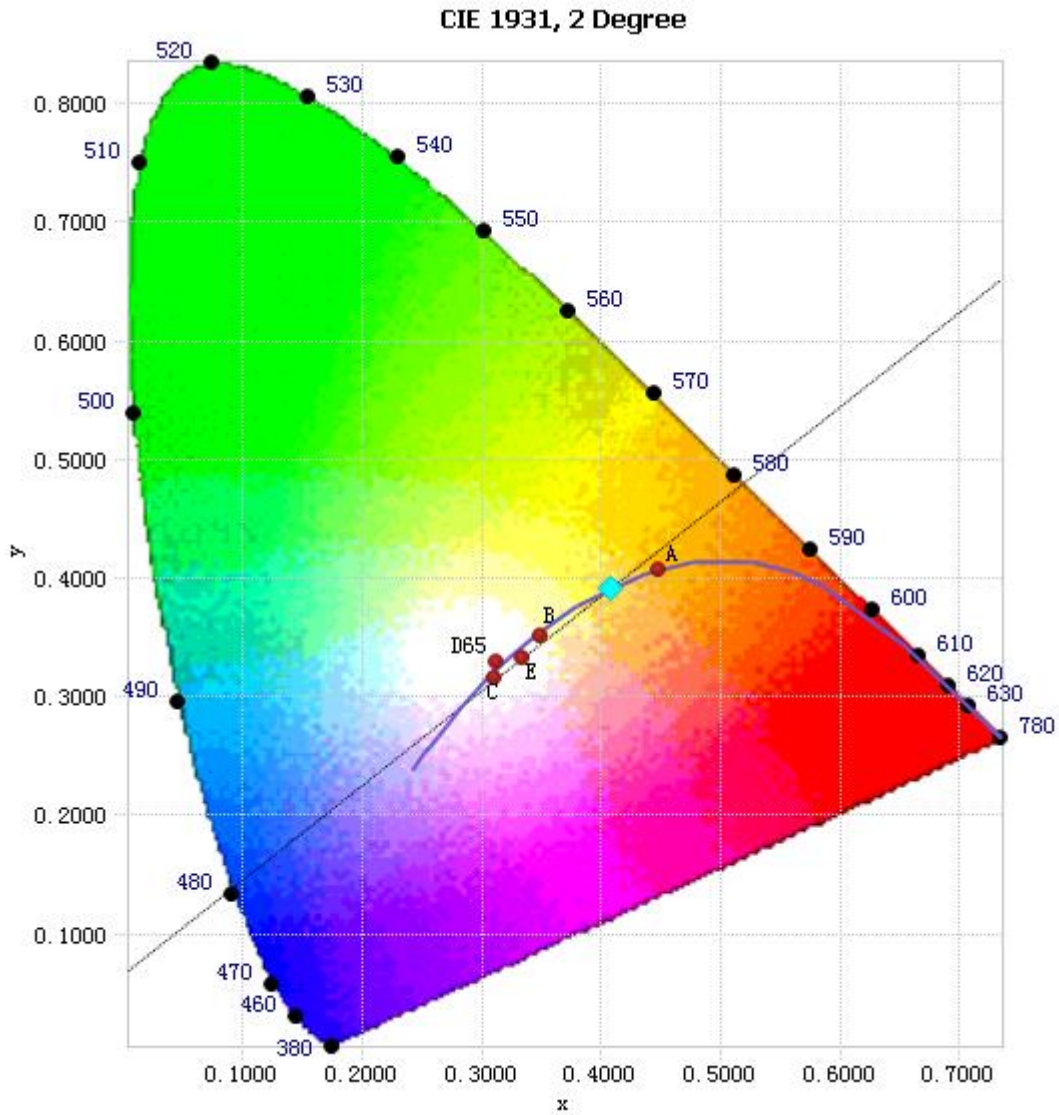


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	2.72E-04	485	8.70E-03	590	3.31E-02	695	4.96E-03
385	2.70E-04	490	9.67E-03	595	3.35E-02	700	4.27E-03
390	2.79E-04	495	1.12E-02	600	3.35E-02	705	3.65E-03
395	3.21E-04	500	1.30E-02	605	3.30E-02	710	3.13E-03
400	3.61E-04	505	1.47E-02	610	3.22E-02	715	2.67E-03
405	4.39E-04	510	1.61E-02	615	3.10E-02	720	2.29E-03
410	6.23E-04	515	1.73E-02	620	2.93E-02	725	1.97E-03
415	9.76E-04	520	1.83E-02	625	2.75E-02	730	1.67E-03
420	1.58E-03	525	1.91E-02	630	2.56E-02	735	1.43E-03
425	2.52E-03	530	1.99E-02	635	2.35E-02	740	1.22E-03
430	3.95E-03	535	2.06E-02	640	2.14E-02	745	1.04E-03
435	6.23E-03	540	2.13E-02	645	1.92E-02	750	8.84E-04
440	1.03E-02	545	2.22E-02	650	1.72E-02	755	7.62E-04
445	1.74E-02	550	2.32E-02	655	1.53E-02	760	6.55E-04
450	2.48E-02	555	2.43E-02	660	1.35E-02	765	5.62E-04
455	2.37E-02	560	2.55E-02	665	1.19E-02	770	4.89E-04
460	1.72E-02	565	2.70E-02	670	1.03E-02	775	4.17E-04
465	1.38E-02	570	2.85E-02	675	9.01E-03	780	3.60E-04
470	1.13E-02	575	2.99E-02	680	7.82E-03		
475	9.00E-03	580	3.13E-02	685	6.76E-03		
480	8.29E-03	585	3.24E-02	690	5.81E-03		

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

Chromaticity Diagram - Sphere Spectroradiometer Method



Tristimulus values(x, y): (0.4077, 0.3923)

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

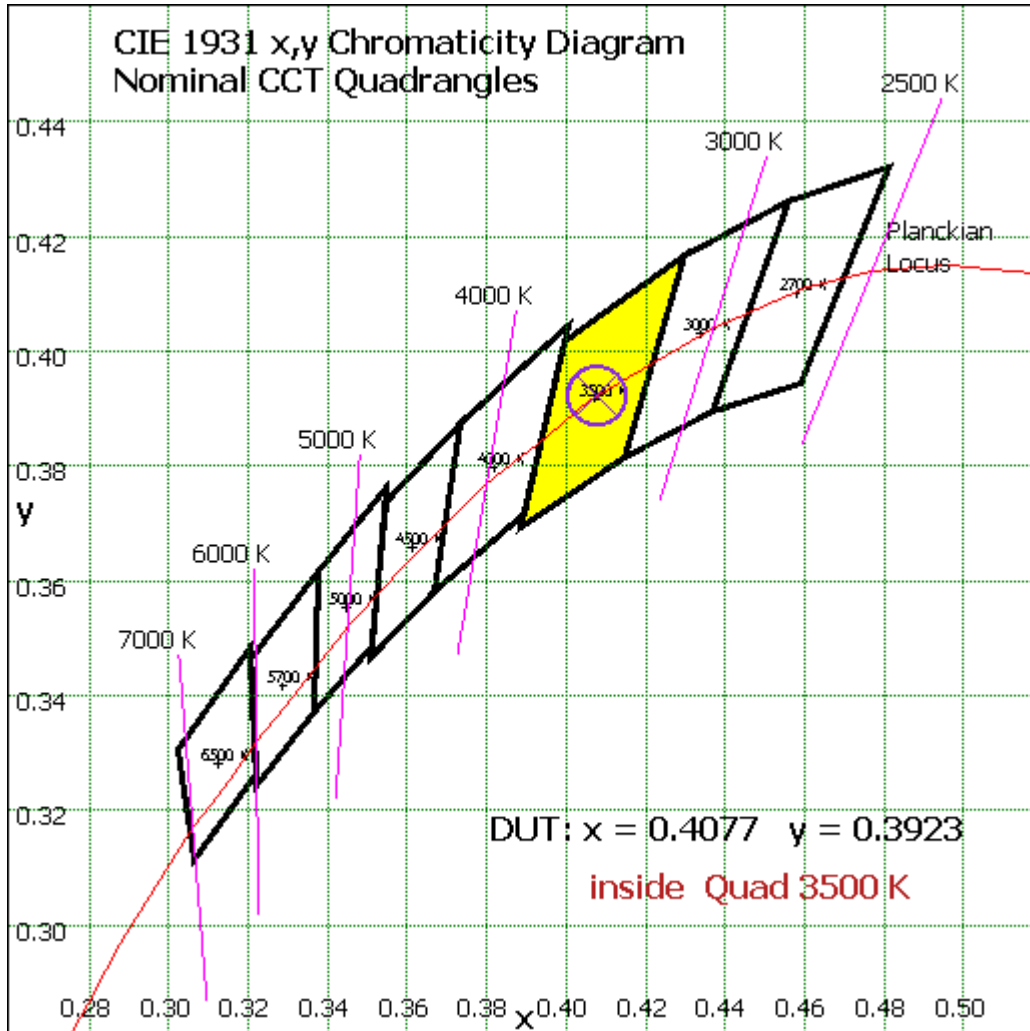


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

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

Zonal Lumen Tabulation- Goniophotometer Method

$\gamma(^{\circ})$	Lumens	% Total
0- 10	47.761	2.70%
10- 20	136.687	7.71%
20- 30	207.079	11.69%
30- 40	250.113	14.12%
40- 50	261.494	14.76%
50- 60	242.858	13.71%
60- 70	201.493	11.37%
70- 80	148.873	8.40%
80- 90	99.319	5.61%
90-100	64.488	3.64%
100-110	42.135	2.38%
110-120	26.891	1.52%
120-130	17.352	0.98%
130-140	11.271	0.64%
140-150	7.147	0.40%
150-160	4.261	0.24%
160-170	2.112	0.12%
170-180	0.527	0.03%
Total	1771.9	100%

$\gamma(^{\circ})$	Lumens	% Total
0- 60	1145.992	64.68%
60- 90	449.685	25.38%
0-90	1595.677	90.06%
90- 180	176.184	9.94%
0- 180	1771.9	100%

Table 5: Zonal Lumen Data

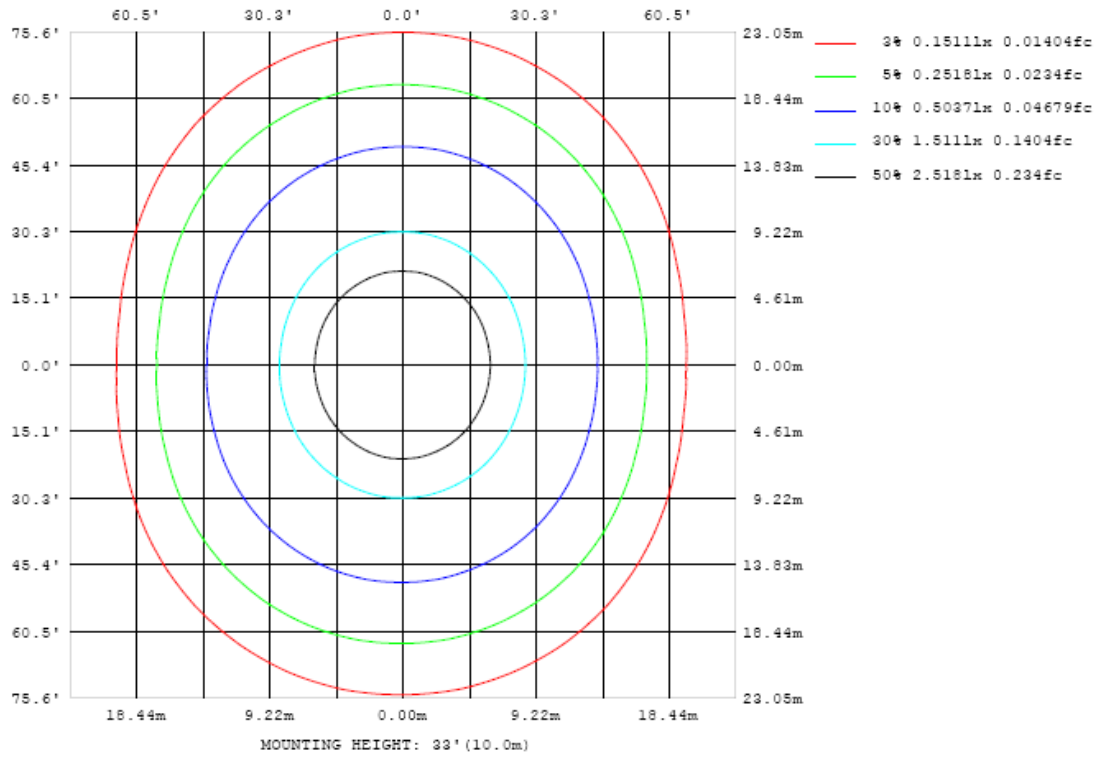


Chart 4: Beam Angle

Luminous Intensity Distribution Plots- Goniophotometer Method

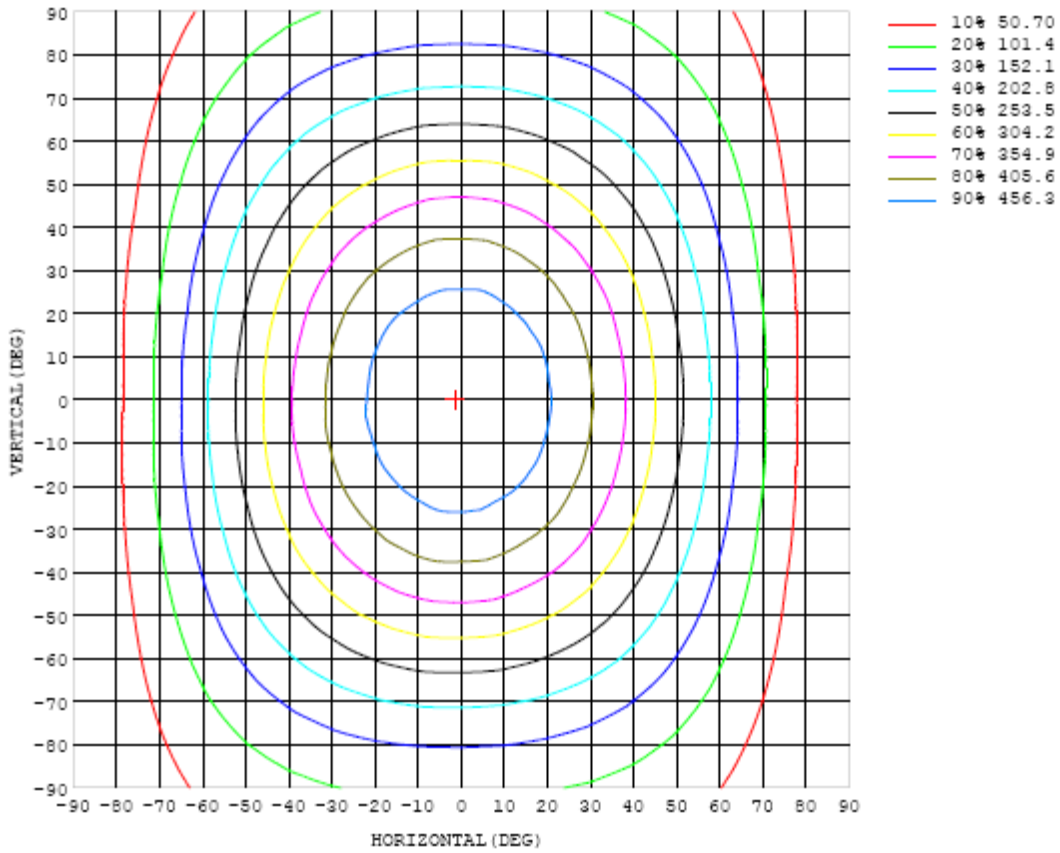


Chart 5: Illuminance Plot (Footcandles)

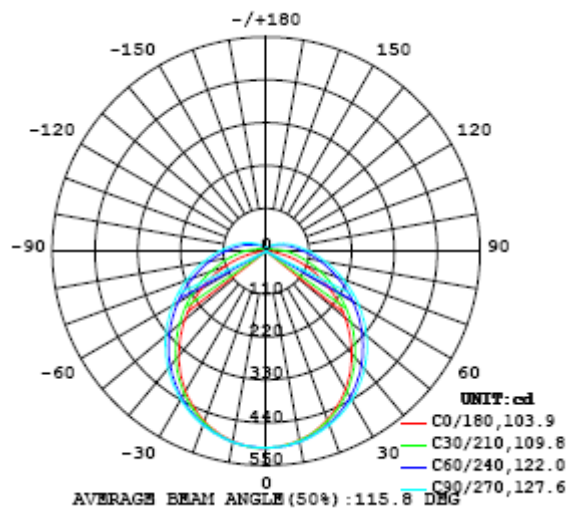


Chart 6: Polar Candela Distribution

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	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
5	500	501	502	501	500	503	502	503	502	503	503	503	503	505	503	503	502	501	502
10	492	493	493	494	494	495	496	496	498	497	498	498	496	496	498	495	497	494	495
15	479	479	478	480	482	484	486	485	489	486	488	489	487	486	486	484	484	483	482
20	460	460	460	463	466	468	471	473	475	474	476	475	474	471	470	468	466	465	464
25	436	437	439	441	445	450	453	455	460	459	461	459	456	454	451	448	445	443	442
30	408	409	412	416	422	427	432	435	441	441	441	439	436	432	427	423	418	417	415
35	377	378	381	387	394	401	408	413	418	418	420	417	412	407	401	396	389	386	384
40	342	343	348	355	364	374	381	387	393	393	395	391	387	379	372	364	356	352	349
45	304	306	312	321	332	343	352	358	365	367	368	363	357	349	341	331	321	316	312
50	265	267	274	285	298	311	321	329	336	337	338	334	327	318	308	296	285	277	273
55	225	228	236	250	264	278	290	298	304	306	306	302	295	285	273	260	246	238	233
60	185	188	198	213	230	245	258	266	273	275	275	270	263	252	239	224	209	198	193
65	146	150	162	179	196	213	226	234	241	243	243	239	231	219	205	189	171	159	152
70	107	112	127	146	165	182	194	204	210	211	212	207	200	188	173	156	137	122	112
75	69.8	76.8	95.3	117	137	153	165	174	180	182	182	177	170	159	144	126	104	86.0	74.8
80	36.4	46.2	67.7	90.3	111	128	140	149	154	155	155	151	144	133	118	98.4	76.0	54.6	41.0
85	10.7	22.9	45.7	68.7	88.7	105	117	124	130	131	131	127	120	110	94.8	75.9	53.1	29.9	13.7
90	0.26	9.59	30.0	51.4	70.4	85.9	96.9	104	109	111	110	107	100	90.0	75.7	57.3	35.8	14.5	0.75
95	0.35	4.32	19.8	38.7	55.9	70.2	80.6	87.5	91.9	93.3	93.0	89.5	83.2	73.4	60.3	43.3	24.1	6.77	0.34
100	0.58	2.91	13.1	28.9	44.4	57.4	67.1	73.7	77.7	78.6	78.2	75.2	69.3	60.1	47.9	32.8	16.4	4.06	0.47
105	0.97	2.65	9.74	21.7	34.9	46.8	55.7	61.9	65.7	66.9	66.4	63.2	57.7	49.2	37.9	24.4	11.6	3.28	0.79
110	1.44	2.90	8.06	17.0	27.5	37.5	45.8	51.6	55.5	56.5	55.9	53.0	47.5	39.6	29.5	18.7	9.02	3.17	1.19
115	1.94	3.24	7.16	14.0	22.2	30.3	37.0	42.1	45.5	46.7	46.1	43.2	38.1	31.5	23.6	15.1	7.62	3.39	1.63
120	2.45	3.68	6.76	12.0	18.6	25.1	30.7	34.9	37.6	38.2	37.8	35.5	31.5	26.0	19.5	12.7	6.97	3.61	2.06
125	2.98	4.14	6.54	10.6	15.8	21.1	25.7	29.1	31.5	32.1	31.7	29.6	26.2	21.7	16.4	11.0	6.67	4.03	2.55
130	3.48	4.56	6.49	9.73	13.7	18.0	21.7	24.5	26.4	27.0	26.6	24.9	22.1	18.4	14.0	9.88	6.58	4.48	3.03
135	3.76	4.90	6.51	9.01	12.1	15.4	18.4	20.7	22.3	22.8	22.4	21.0	18.7	15.8	12.3	9.15	6.51	4.88	3.48
140	4.07	5.31	6.60	8.46	10.9	13.4	15.7	17.6	18.8	19.2	18.9	17.8	16.0	13.6	11.0	8.62	6.61	5.26	3.87
145	4.37	5.66	6.66	8.09	9.89	11.8	13.5	14.9	16.0	16.3	16.1	15.1	13.7	11.9	10.0	8.08	6.74	5.63	4.19
150	4.62	5.94	6.74	7.75	9.10	10.5	11.7	12.8	13.5	13.7	13.5	12.9	11.9	10.6	9.13	7.92	6.87	5.94	4.52
155	4.90	6.29	6.86	7.46	8.27	9.39	10.2	11.0	11.5	11.6	11.5	11.1	10.4	9.45	8.55	7.77	6.98	6.34	5.03
160	4.61	6.02	6.97	7.28	7.56	8.08	9.08	9.48	9.85	9.96	9.93	9.62	9.16	8.70	8.19	7.59	6.89	6.53	5.53
165	4.30	5.31	6.13	6.65	7.17	7.39	7.79	8.54	8.70	8.77	8.79	8.67	8.46	8.18	7.79	7.34	7.07	6.53	5.06
170	4.29	4.47	4.97	5.26	5.63	6.34	6.96	7.27	7.57	7.86	7.89	7.82	7.68	7.49	7.35	7.30	7.08	5.62	4.47
175	4.47	4.27	4.43	4.39	4.36	4.33	4.51	5.18	5.99	6.50	6.95	7.21	7.34	7.31	6.95	6.09	5.10	4.67	4.46
180	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93

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	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504		
5	504	504	504	505	504	502	503	504	503	503	503	503	502	502	501	500	502		
10	496	497	497	498	498	497	497	498	497	497	496	495	494	494	494	494	492		
15	482	483	484	486	487	486	487	489	486	487	487	485	483	482	481	480	478		
20	465	466	468	470	472	473	474	475	474	476	472	470	467	465	464	462	459		
25	442	443	446	450	453	454	457	460	460	459	456	452	449	444	442	438	436		
30	415	418	422	427	432	434	437	441	440	439	436	430	426	421	416	411	408		
35	385	388	393	399	406	410	414	418	417	417	412	407	401	394	387	380	377		
40	349	354	361	369	378	383	388	393	392	393	387	381	373	364	356	347	343		
45	313	319	327	337	347	354	361	367	366	365	360	351	343	332	321	311	306		
50	274	281	291	304	315	325	331	338	338	337	331	322	310	299	286	275	267		
55	235	243	255	269	283	293	301	308	308	307	301	291	279	266	251	237	227		
60	195	205	219	235	251	262	271	278	278	276	270	260	247	232	216	200	189		
65	155	167	184	202	218	231	240	247	248	247	240	230	216	200	181	163	150		
70	117	132	151	170	188	201	211	217	218	217	211	201	186	169	149	129	113		
75	80.9	99.3	121	142	160	173	182	189	191	189	183	173	159	142	121	98.3	78.5		
80	49.7	70.9	94.3	116	134	148	157	163	164	163	157	148	134	117	95.6	71.5	49.3		
85	25.0	48.6	72.3	93.9	111	125	133	140	141	140	134	125	112	95.1	74.5	50.7	26.7		
90	10.4	32.0	54.9	75.2	92.3	105	113	119	120	119	114	105	93.3	77.1	57.7	35.1	13.3		
95	4.38	21.1	41.3	60.5	75.9	87.9	95.9	101	103	101	96.6	89.0	77.3	62.6	44.3	24.3	6.87		
100	2.91	13.9	31.0	48.2	62.7	73.4	80.9	85.8	87.3	86.2	81.9	74.4	64.2	50.5	33.9	16.8	4.69		
105	2.60	10.4	23.0	37.7	51.2	61.5	68.2	72.7	73.9	73.1	69.1	62.7	52.8	40.1	25.9	12.8	3.92		
110	2.77	8.44	18.1	29.3	40.6	50.2	56.9	61.2	62.6	61.6	57.9	51.4	42.4	31.9	20.8	10.6	3.91		
115	3.17	7.35	15.0	24.1	32.9	40.5	46.3	50.2	51.5	50.6	47.3	42.0	34.9	26.2	17.2	9.30	4.11		
120	3.59	6.85	12.8	20.1	27.5	33.7	38.4	41.8	42.8	42.1	39.5	35.1	29.1	22.0	14.8	8.55	4.39		
125	3.83	6.64	11.2	17.1	23.1	28.3	32.3	35.1	36.0	35.5	33.2	29.5	24.6	18.8	13.0	8.07	4.62		
130	4.44	6.63	10.2	14.7	19.6	23.8	27.2	29.6	30.3	29.8	27.9	24.9	20.9	16.3	11.7	7.69	4.50		
135	4.77	6.69	9.48	13.0	16.8	20.2	22.9	24.9	25.5	25.2	23.5	21.1	17.9	14.3	10.7	7.52	4.91		
140	5.09	6.72	8.96	11.7	14.6	17.3	19.4	20.9	21.4	21.2	20.0	18.0	15.4	12.6	9.80	7.38	5.50		
145	5.23	6.73	8.55	10.6	12.8	14.8	16.5	17.7	18.1	17.8	16.9	15.4	13.5	11.3	9.10	7.10	5.73		
150	5.27	6.91	8.20	9.67	11.3	12.7	13.9	14.9	15.2	15.1	14.3	13.2	11.8	10.2	8.35	6.78	5.76		
155	5.43	6.97	7.85	8.89	10.0	11.1	11.9	12.6	12.8	12.7	12.2	11.5	10.5	9.03	7.71	7.34	5.64		
160	4.78	6.31	7.58	8.31	8.99	9.80	10.3	10.7	10.9	10.9	10.6	10.0	9.10	8.31	7.78	7.04	5.35		
165	4.23	4.99	6.28	7.99	8.42	8.84	9.16	9.42	9.51	9.50	9.24	8.74	7.74	6.86	6.23	5.60	4.59		
170	4.08	4.31	4.32	4.77	6.47	7.79	8.18	8.25	8.29	8.30	7.26	5.85	5.34	5.14	4.80	4.52	4.28		
175	4.33	4.72	5.02	5.05	4.96	5.31	5.38	5.21	4.76	3.72	4.75	5.12	5.31	5.00	4.96	4.80	4.66		
180	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93		

Table 7: Luminous Intensity Data

EQUIPMENT LIST

Test Equipment	Model	Equipment No.	Calibration Date	Calibration Due date
Goniophotometer system	GO-R5000	HZTE011-01	Aug. 14, 2018	Aug. 13, 2019
Digital Power Meter	PF2010A	HZTE028-01	Sep. 12, 2018	Sep. 11, 2019
AC Power Supply	DPS1060	HZTE001-06	Aug. 09, 2018	Aug. 08, 2019
DC Power Supply	WY12010	HZTE004-03	Aug. 09, 2018	Aug. 08, 2019
Temperature recorder	JM624U	HZTE018-08	Aug. 09, 2018	Aug. 08, 2019
Temperature and humidity recorder	JR900	HZTE018-01	Aug. 09, 2018	Aug. 08, 2019
Standard source	D908	HZTE012-01	Aug. 14, 2018	Aug. 13, 2019
Integrate Sphere system	2M	HZTE015-01	Aug. 16, 2018	Aug. 15, 2019
Digital Power Meter	WT210	HZTE008-01	Aug. 02, 2018	Aug. 01, 2019
AC Power Supply	PCR 500L	HZTE001-07	Aug. 09, 2018	Aug. 08, 2019
DC Power Supply	IT6154	HZTE004-04	Aug. 09, 2018	Aug. 08, 2019
Standard source	SCL-1400	HZTE012-02	Aug. 16, 2018	Aug. 15, 2019
Temperature and humidity recorder	JR900	HZTE018-02	Aug. 09, 2018	Aug. 08, 2019
Temperature Meter	TES1310	HZTE017-01	Aug. 09, 2018	Aug. 08, 2019

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 4π . 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 2.1% 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 2.3% with a coverage factor $k=2$.

Color Characteristics Measurements

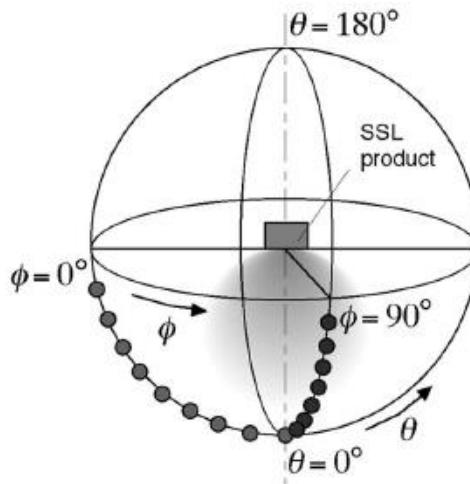
The color characteristics of SSL products include chromaticity coordinates, correlated color temperature, and color rendering index. These characteristics of SSL products may be spatially non-uniform, and thus, in order that they can be specified accurately, the color quantities shall be measured as 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° 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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