LM-79-08 Test Report

for

Revolution Lighting Technologies, Inc.

2280 Ward Ave. Simi Valley, CA 93065

LED Tube

Model: 203101-113

Laboratory: Leading Testing Laboratories

NVLAP CODE: 200960-0

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Report No.: HZ18110016an

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

Review by: April Zou

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: **203101-113**

Luminous Efficacy (Lumens /Watt)	Total Luminous Flux (Lumens)	Power (Watts)	Power Factor
125.5	1832.0	14.60	0.9812

CCT (K)	CRI	Stabilization Time (Light & Power)
4022	82.9	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. 21, 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

TABLE OF CONTENT

Sample Photo

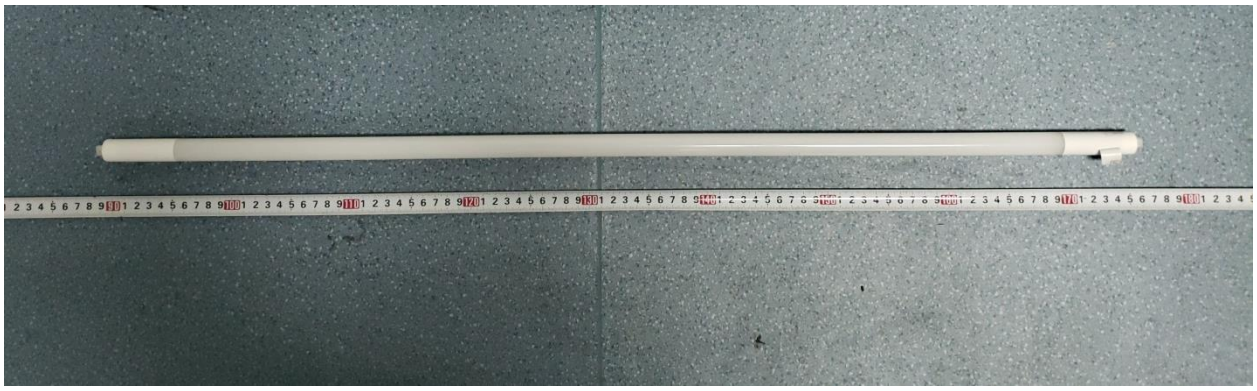


Figure 1- Overview of the sample

Equipment Under Test (EUT)	
Name	: LED Tube
Model	: 203101-113
Electrical Ratings	: 120-277V, 60Hz
Product Description	: 4000K
Manufacturer	: Revolution Lighting Technologies, Inc.
Address	: 2280 Ward Ave. Simi Valley, CA 93065

TEST RESULTS

Test ambient temperature was 25.1℃.

Base orientation was Horizontal. 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	277.0
Voltage frequency (Hz)	60	60
Test Current (A)	0.124	0.056
Power Factor	0.9812	0.9582
Test Power (W)	14.60	14.97
THD A%	18.57	21.16
Luminous Efficacy (lm/W)	125.5	122.3
Total Luminous Flux (lm)	1832.0	1831.0
Color Rendering Index (CRI)	82.9	
R9	6	
Correlated Color Temperature (CCT)(K)	4022	
Chromaticity Chroma x	0.3802	
Chromaticity Chroma y	0.3792	
Chromaticity Chroma u	0.2240	
Chromaticity Chroma v	0.3351	
Duv	0.0005	
Chromaticity Chroma u ’	0.2240	
Chromaticity Chroma v’	0.5026	

Special Color Rendering Indices	
R1	80.9
R2	89.4
R3	95.4
R4	81.6
R5	81.2
R6	85.4
R7	85.8
R8	63.6
R9	6
R10	74.9
R11	80.6
R12	63
R13	83.1
R14	97.7

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 25.0 ℃.

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)	0.125
Power Factor	0.9801
Power (W)	14.69
Luminous Efficacy (lm/W)	123.0
Total Luminous Flux (lm)	1806.4
Beam Angle (°)	104.2（0^o-180^o）/128.3(90^o-270^o)
Center Beam Candle Power (cd)	512
Maximum Beam Candle Power (cd)	512.9 (At: C=320.0, Gamma=0.5)
Spacing Criteria	1.21（0^o-180^o）/1.31 (90^o-270^o)
Zonal Lumens in the 0 °-60 °Zone	64.63%
Zonal Lumens in the 60 °-90 °Zone	25.43%
Zonal Lumens in the 90 °-120 °Zone	7.53%
Zonal Lumens in the 120 °-180 °Zone	2.40%

Table 3: Test data per Goniophotometer Method

Spectral Power Distribution - Sphere Spectroradiometer Method

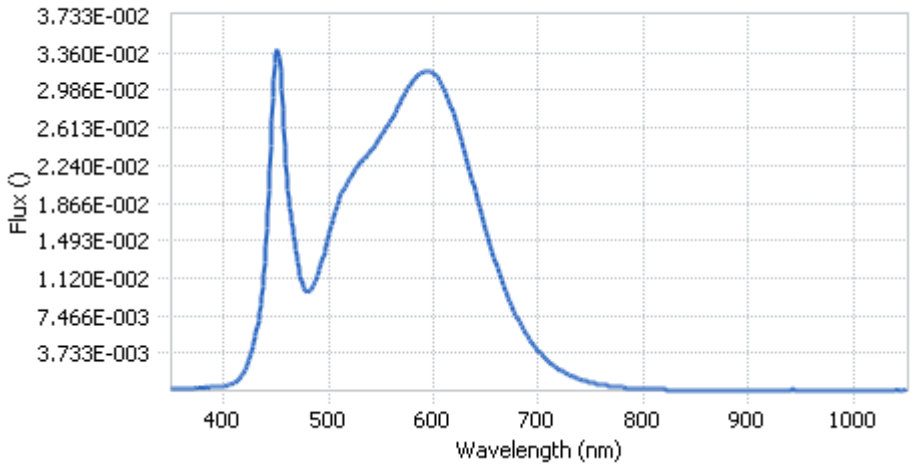
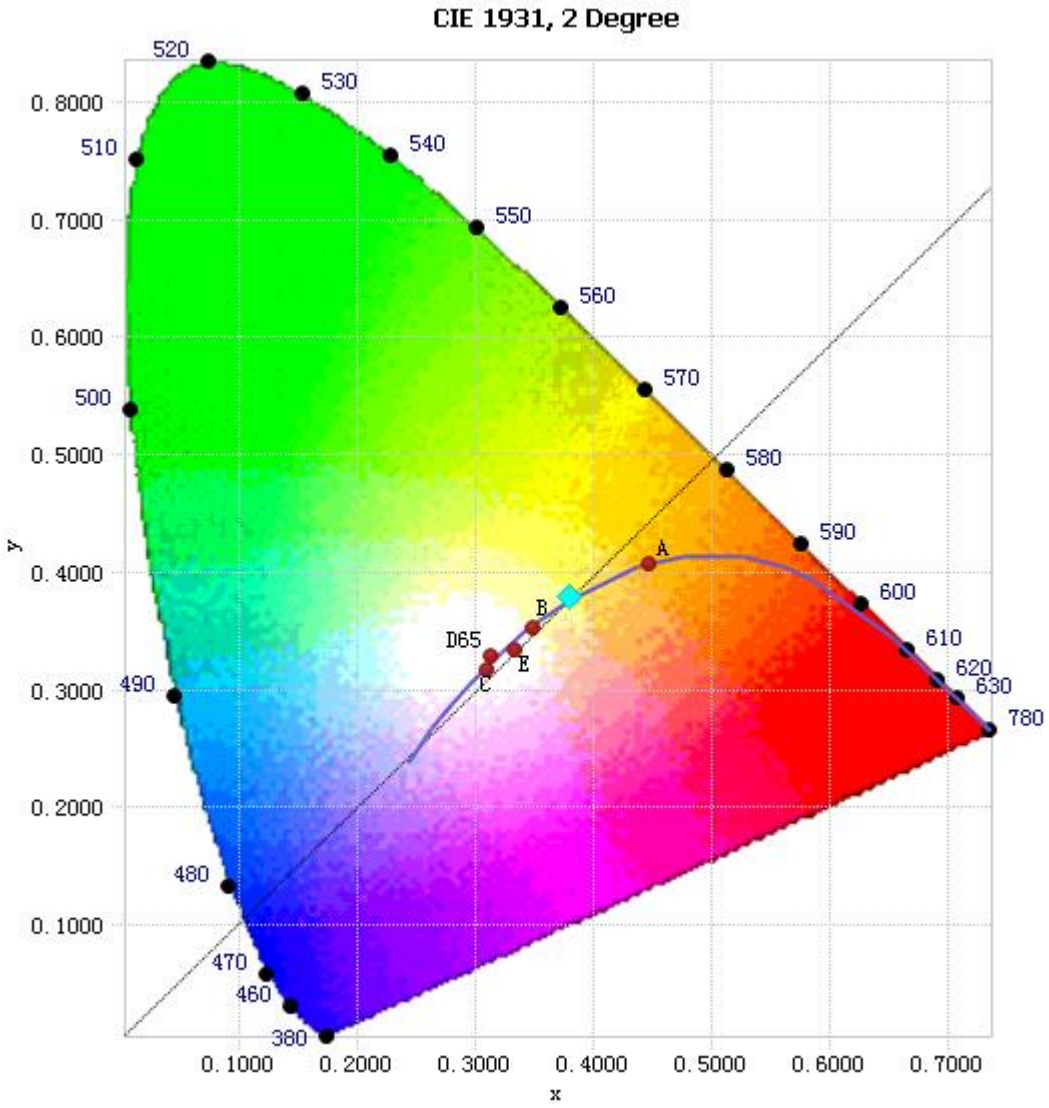


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	3.12E-04	485	1.04E-02	590	3.17E-02	695	4.57E-03
385	3.01E-04	490	1.16E-02	595	3.17E-02	700	3.94E-03
390	3.41E-04	495	1.34E-02	600	3.15E-02	705	3.37E-03
395	3.86E-04	500	1.55E-02	605	3.09E-02	710	2.89E-03
400	4.40E-04	505	1.74E-02	610	3.00E-02	715	2.46E-03
405	5.53E-04	510	1.90E-02	615	2.87E-02	720	2.10E-03
410	8.01E-04	515	2.02E-02	620	2.71E-02	725	1.81E-03
415	1.26E-03	520	2.12E-02	625	2.55E-02	730	1.54E-03
420	2.06E-03	525	2.19E-02	630	2.35E-02	735	1.32E-03
425	3.37E-03	530	2.27E-02	635	2.17E-02	740	1.13E-03
430	5.33E-03	535	2.33E-02	640	1.97E-02	745	9.65E-04
435	8.54E-03	540	2.39E-02	645	1.77E-02	750	8.25E-04
440	1.43E-02	545	2.45E-02	650	1.59E-02	755	7.08E-04
445	2.44E-02	550	2.53E-02	655	1.41E-02	760	6.13E-04
450	3.36E-02	555	2.61E-02	660	1.25E-02	765	5.23E-04
455	3.00E-02	560	2.70E-02	665	1.09E-02	770	4.54E-04
460	2.11E-02	565	2.81E-02	670	9.53E-03	775	3.88E-04
465	1.69E-02	570	2.91E-02	675	8.31E-03	780	3.36E-04
470	1.34E-02	575	3.00E-02	680	7.20E-03		
475	1.05E-02	580	3.08E-02	685	6.23E-03		
480	9.84E-03	585	3.14E-02	690	5.35E-03		

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

Chromaticity Diagram - Sphere Spectroradiometer Method



Tristimulus values(x, y): (0.3802, 0.3792)

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

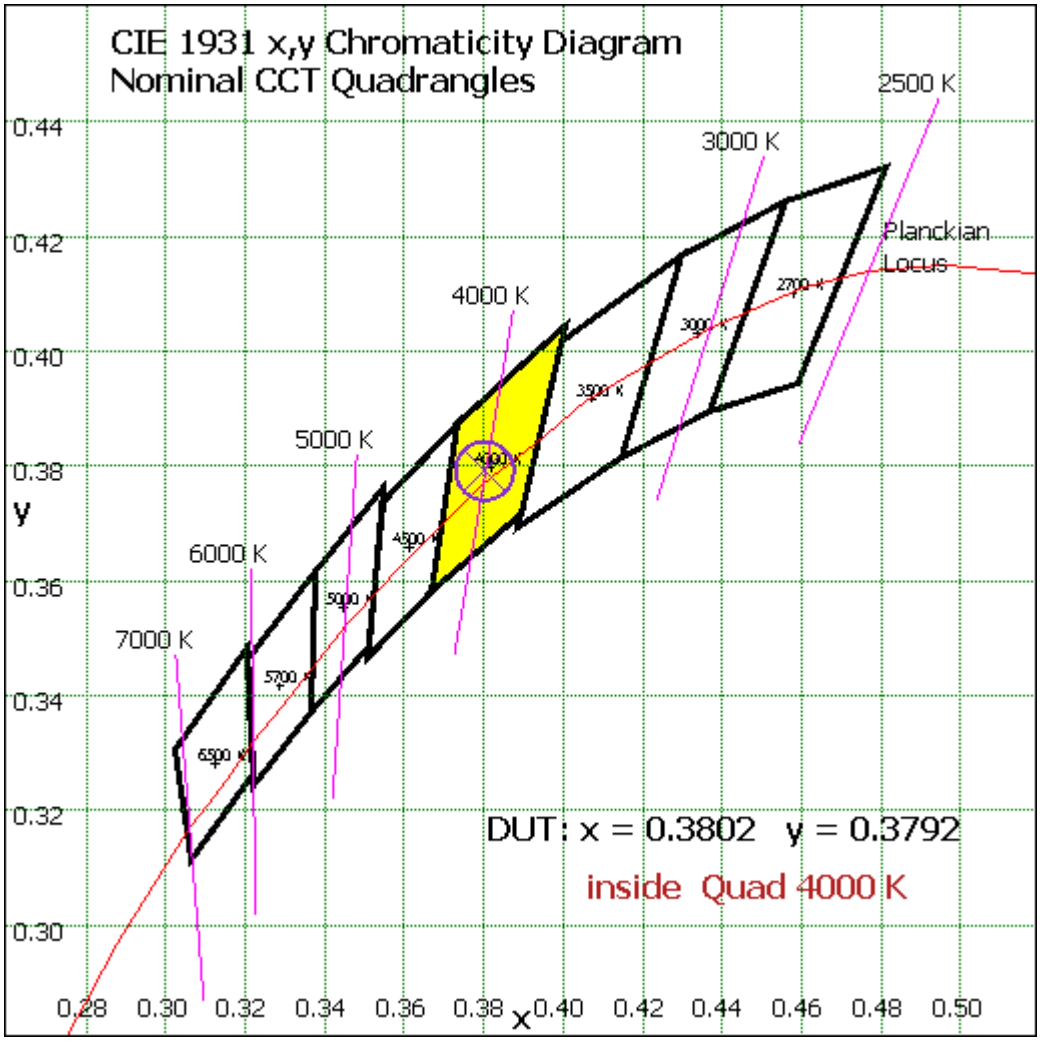


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

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

Zonal Lumen Tabulation- Goniophotometer Method

γ(°)	Lumens	% Total
0- 10	48.444	2.68%
10- 20	138.807	7.68%
20- 30	210.63	11.66%
30- 40	254.778	14.10%
40- 50	266.795	14.77%
50- 60	248.011	13.73%
60- 70	205.823	11.39%
70- 80	152.123	8.42%
80- 90	101.472	5.62%
90-100	65.832	3.64%
100-110	42.809	2.37%
110-120	27.411	1.52%
120-130	17.686	0.98%
130-140	11.48	0.64%
140-150	7.256	0.40%
150-160	4.315	0.24%
160-170	2.15	0.12%
170-180	0.549	0.03%
Total	1806.4	100%

γ(°)	Lumens	% Total
0- 60	1167.465	64.63%
60- 90	459.418	25.43%
0-90	1626.883	90.06%
90- 180	179.488	9.94%
0- 180	1806.4	100%

Table 5: Zonal Lumen Data

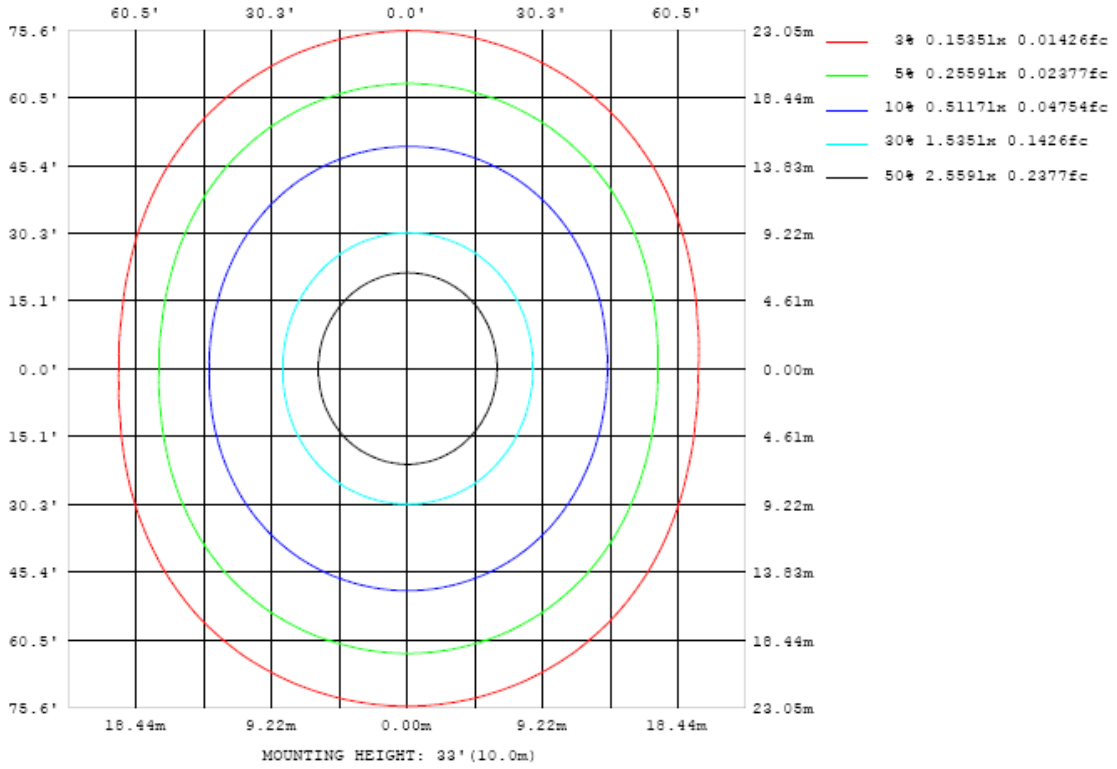


Chart 4: Beam Angle

Luminous Intensity Distribution Plots- Goniophotometer Method

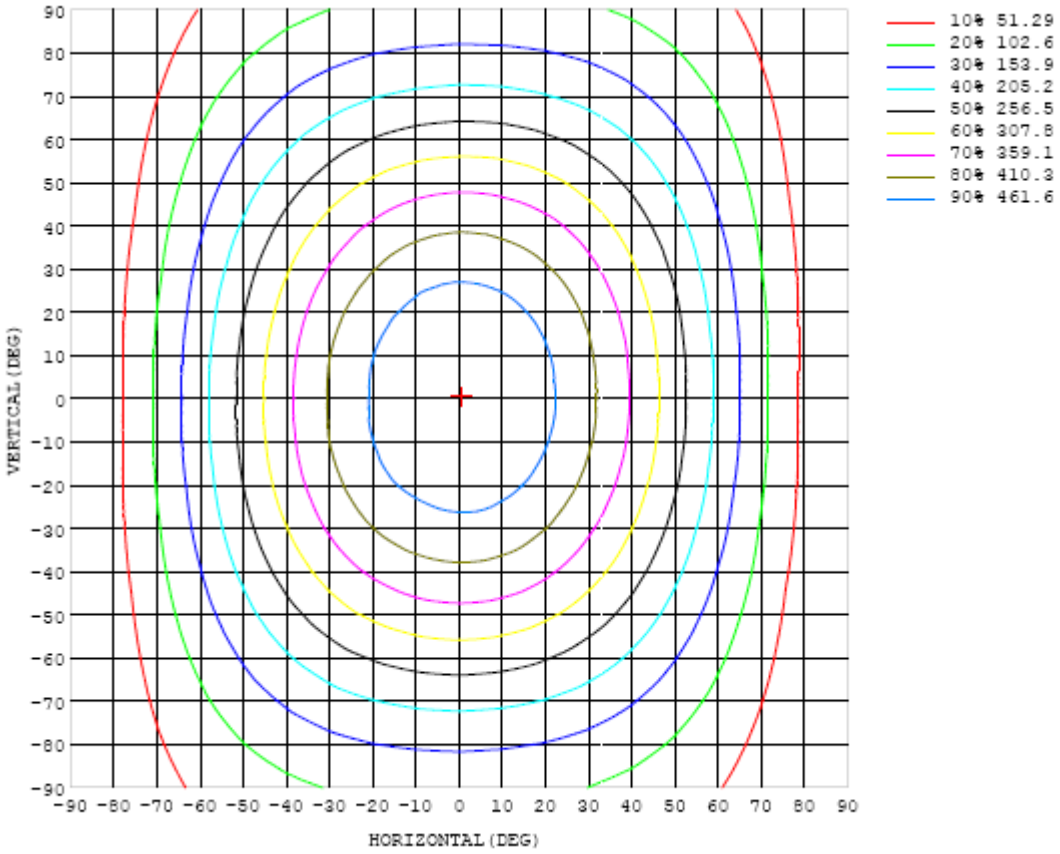


Chart 5: Illuminance Plot (Footcandles)

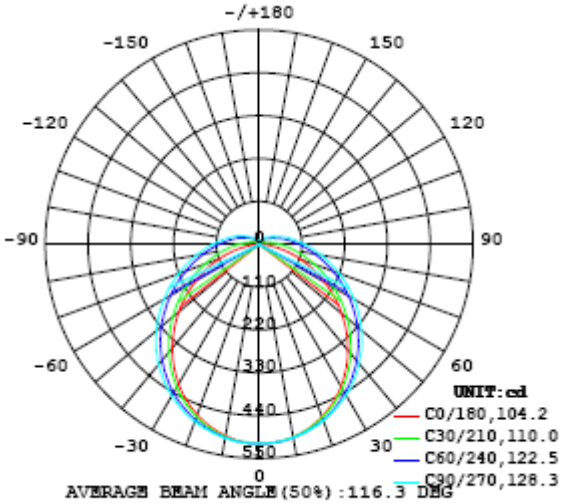


Chart 6: Polar Candela Distribution

Luminous Intensity Data- Goniophotometer Method

Table--1 UNIT: cd

γ (DEG) \ C (DEG)	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
0	512	512	512	512	512	512	512	512	512	512	512	512	512	512	512	512	512	512	512
5	510	510	510	510	510	511	510	511	511	509	509	509	509	509	509	509	508	509	509
10	503	503	503	503	503	504	504	504	504	505	504	503	503	503	503	501	500	501	499
15	490	490	491	491	491	493	494	495	495	495	494	494	493	492	490	489	487	485	485
20	471	472	472	473	476	478	480	481	482	482	482	481	480	476	474	472	470	467	465
25	449	450	451	453	456	459	462	465	466	466	464	463	460	457	454	450	446	444	442
30	420	422	424	427	432	436	442	445	447	446	445	444	441	435	430	425	420	416	414
35	390	391	394	398	405	411	417	422	424	424	423	419	416	410	403	396	390	385	383
40	355	356	360	366	374	382	390	395	399	400	398	394	389	382	373	365	357	350	347
45	317	319	324	331	341	352	361	368	372	373	371	367	360	352	341	331	321	313	309
50	277	279	286	295	308	319	330	337	342	343	342	337	330	319	307	294	283	274	270
55	237	239	247	259	273	287	298	307	312	313	311	306	299	286	273	259	245	234	229
60	195	198	207	222	238	253	265	275	280	282	280	275	266	254	239	222	207	194	188
65	154	158	170	186	203	220	233	242	248	250	248	243	234	222	206	187	169	154	148
70	114	119	133	152	171	188	202	211	217	219	217	213	204	191	174	154	134	117	109
75	75.8	81.8	99.5	121	141	159	173	182	188	190	188	183	175	162	145	125	103	81.8	71.3
80	41.4	49.5	70.5	93.7	115	133	146	155	160	162	161	156	148	136	119	98.4	75.1	52.1	37.4
85	13.7	24.2	47.6	70.9	91.9	109	122	131	136	138	136	132	125	113	96.6	76.3	53.4	28.8	11.1
90	0.84	9.61	30.8	53.5	73.1	89.6	102	110	115	117	115	112	104	93.3	77.7	58.9	36.8	14.5	0.51
95	0.36	3.80	19.4	39.5	58.1	73.1	84.9	92.8	97.4	99.1	97.9	94.2	87.6	77.0	62.8	45.0	25.1	7.07	0.40
100	0.52	2.45	12.7	28.5	45.4	59.7	70.3	77.9	82.0	83.8	82.8	79.3	73.0	63.3	50.0	33.6	17.1	4.96	0.60
105	0.88	2.34	9.41	21.4	34.8	47.5	57.9	65.0	68.9	70.5	69.8	66.4	60.4	51.3	38.8	25.6	13.1	4.02	0.98
110	1.29	2.56	7.50	16.8	27.6	37.8	46.6	53.1	57.1	58.8	57.9	54.8	48.9	40.9	31.4	20.6	10.7	3.99	1.45
115	1.78	2.82	6.69	13.8	22.5	31.1	38.5	43.7	47.0	48.4	47.7	45.2	40.7	34.0	25.8	17.1	9.41	4.18	1.95
120	2.29	2.84	6.27	11.7	18.8	25.8	32.0	36.6	39.5	40.6	40.0	37.9	34.0	28.4	21.6	14.6	8.57	4.28	2.47
125	2.80	3.11	5.74	10.3	15.9	21.7	26.9	30.8	33.4	34.3	33.8	31.8	28.6	23.9	18.4	12.9	8.00	4.52	3.01
130	3.25	4.16	5.73	9.41	13.8	18.5	22.7	25.9	28.1	28.9	28.6	26.9	24.1	20.3	15.9	11.4	7.11	4.82	3.50
135	3.70	4.57	5.85	8.42	12.2	16.0	19.3	22.0	23.7	24.5	24.1	22.8	20.5	17.5	13.9	10.3	7.08	5.09	3.86
140	4.13	5.01	5.67	7.70	10.8	13.8	16.5	18.7	20.1	20.7	20.4	19.3	17.5	15.1	12.2	8.95	7.25	5.40	4.24
145	4.58	5.31	5.90	7.47	9.35	11.8	14.1	15.8	16.9	17.4	17.2	16.4	15.0	13.0	10.4	8.56	7.01	5.57	4.58
150	5.00	5.22	6.62	7.02	8.52	10.2	12.0	13.4	14.3	14.7	14.5	13.9	12.6	11.1	9.51	8.26	7.06	5.64	4.90
155	5.48	5.53	6.76	7.27	7.73	9.09	10.3	11.2	11.8	12.1	12.1	11.6	11.0	10.0	8.66	7.62	7.22	5.60	5.22
160	5.85	4.88	6.23	7.43	8.01	8.01	8.79	9.81	10.4	10.6	10.6	10.3	9.63	8.65	8.10	7.66	6.95	5.30	5.07
165	5.35	4.37	4.92	6.15	7.83	8.30	8.60	8.74	8.69	8.58	8.63	8.69	8.61	7.75	6.75	6.25	5.62	4.70	4.74
170	4.66	4.29	4.26	4.33	4.70	6.48	7.85	8.26	8.31	8.33	8.29	7.36	6.00	5.47	5.14	4.94	4.65	4.51	4.56
175	4.72	4.56	4.84	5.10	5.15	5.05	5.36	5.51	5.06	5.07	3.81	5.04	5.41	5.60	5.30	5.24	5.08	4.96	4.76
180	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14

Table 6: Luminous Intensity Data

Table--2 UNIT: cd

γ (DEG) \ C (DEG)	190	200	210	220	230	240	250	260	270	280	290	300	310	320	330	340	350		
0	512	512	512	512	512	512	512	512	512	512	512	512	512	512	512	512	512		
5	509	508	509	510	510	510	510	512	509	510	511	511	511	511	509	509	510		
10	499	500	502	502	502	504	506	506	505	505	506	506	506	504	503	502	501		
15	486	487	490	491	491	493	495	496	496	496	496	496	494	494	493	491	489		
20	467	469	471	474	476	479	482	484	484	483	483	482	481	479	477	474	471		
25	444	447	449	453	457	461	465	467	468	467	467	465	462	459	457	452	449		
30	416	420	424	428	434	440	446	449	449	449	448	446	442	437	431	426	422		
35	385	390	395	401	409	415	422	426	428	427	424	421	416	410	403	397	391		
40	349	355	362	370	380	388	396	400	403	402	400	395	389	380	371	364	358		
45	312	318	327	337	349	359	368	373	375	375	372	367	358	348	338	328	320		
50	273	280	291	304	317	329	337	343	346	345	342	336	326	315	302	291	281		
55	232	241	254	268	282	295	306	312	315	314	310	304	294	281	266	252	241		
60	192	202	217	234	250	264	274	280	283	282	279	272	260	246	229	213	201		
65	152	165	182	200	217	232	242	248	251	251	247	239	228	212	194	176	162		
70	114	130	149	169	186	201	211	218	221	220	216	208	196	179	160	141	123		
75	78.2	96.8	119	140	157	172	182	188	191	191	187	179	167	150	130	108	87.2		
80	46.4	68.6	92.3	114	132	146	156	161	164	164	160	152	140	124	103	78.9	55.6		
85	22.6	46.3	70.1	91.6	109	123	133	138	141	140	136	129	117	100	79.7	55.5	30.7		
90	9.08	30.2	52.8	73.3	89.9	103	112	117	120	119	115	108	96.4	80.8	60.8	38.0	15.3		
95	4.07	19.9	39.5	58.3	73.9	86.0	94.2	99.3	101	101	96.9	90.1	79.2	64.6	46.3	25.9	7.43		
100	2.86	13.2	29.9	46.3	60.6	71.7	79.7	84.0	86.1	85.2	81.8	75.2	65.2	51.7	35.3	17.9	4.59		
105	2.66	9.96	22.5	36.9	49.7	59.9	67.1	71.2	73.0	72.3	68.9	62.8	53.6	41.4	26.9	12.8	3.67		
110	2.97	8.31	17.8	29.0	40.3	49.7	56.3	60.4	62.0	61.2	57.9	52.2	43.7	32.5	20.7	10.1	3.52		
115	3.40	7.47	14.7	23.6	32.4	40.4	46.6	50.4	51.9	51.1	48.0	42.6	34.8	26.0	16.7	8.58	3.71		
120	3.83	7.07	12.6	19.7	26.9	33.3	38.1	41.2	42.3	41.7	39.0	34.7	28.6	21.5	14.0	7.73	4.04		
125	4.29	6.90	11.3	16.9	22.6	27.8	31.9	34.5	35.3	34.6	32.5	28.9	23.9	18.1	12.1	7.32	4.39		
130	4.78	6.89	10.3	14.6	19.3	23.5	26.8	28.8	29.6	29.1	27.2	24.3	20.2	15.6	10.9	7.16	4.74		
135	5.23	6.93	9.59	12.9	16.6	19.9	22.6	24.3	24.9	24.5	22.9	20.5	17.3	13.5	9.96	7.16	5.21		
140	5.68	6.96	9.03	11.6	14.3	17.1	19.1	20.5	21.0	20.6	19.4	17.5	15.0	12.0	9.34	7.20	5.63		
145	6.06	6.94	8.57	10.6	12.6	14.7	16.3	17.3	17.7	17.5	16.5	15.0	13.0	10.9	8.93	7.22	6.03		
150	6.41	7.02	8.20	9.68	11.2	12.6	13.8	14.7	15.0	14.7	14.0	12.8	11.5	9.99	8.57	7.22	6.43		
155	6.74	7.06	7.80	8.88	10.1	11.1	11.9	12.4	12.6	12.4	12.0	11.2	10.3	9.31	8.25	7.31	6.80		
160	6.56	7.20	7.50	8.03	8.86	9.80	10.3	10.7	10.8	10.7	10.4	10.0	9.41	8.73	7.96	7.36	7.02		
165	5.80	6.43	6.94	7.43	7.82	8.36	8.88	9.29	9.38	9.38	9.22	8.97	8.57	8.12	7.77	7.53	6.94		
170	4.82	5.37	5.62	5.97	6.70	7.38	7.44	7.34	8.13	8.18	8.11	8.02	7.92	7.79	7.66	7.45	6.10		
175	4.56	4.71	4.61	4.60	4.67	4.92	5.62	6.57	7.24	6.96	6.91	7.22	7.45	7.31	6.54	5.49	4.92		
180	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14	3.14		

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.

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The uncertainty of integrating sphere system reported in this document is expended 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 expended uncertainty is 2.3% with a coverage factor k=2.

Color Characteristics Measurements

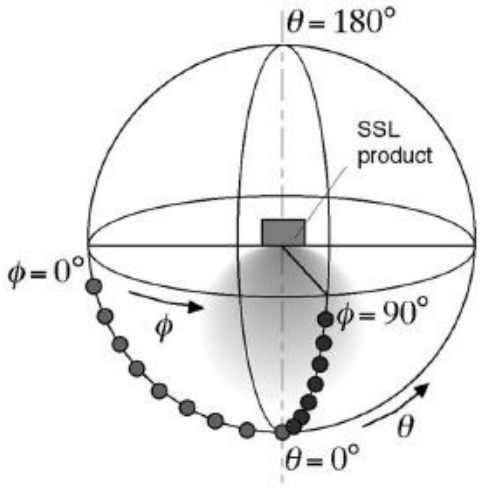
The color characteristics of SSL products include chromaticity coordinates, correlated color temperature, and color rendering index. These characteristics of SSL products may be spatially non-uniform, and thus, in order that they can be specified accurately, the color quantities shall be measured as 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°/180° and C=90°/270°) 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, Δu'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 ***