



LM-79-08 Test Report

for

Philips (China) Investment Co., Ltd.

Building 9, Lane 888, Tianlin Road
Shanghai, China

InstantFit LEDtube

Model: 9290011513(2 lamps+ballast ICN-2TTP40-SC)

Laboratory: Leading Testing Laboratories

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Report No.: HZ15040006a

Review by:

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Engineer: April Zou
Apr. 13, 2015

Approved by:



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Manager: Jim Zhang
Apr. 13, 2015

Test Summary

Sample Tested: 9290011513(2 lamps+ballast ICN-2TTP40-SC)

Photometric and Electrical Measurements for three lamps

Voltage (V AC)	Current (A)	Test power (W) (ballast + 2 tubes)	Power Factor	Total Luminous Flux (lm)	Luminous Efficacy (lm/W)	Total Harmonic Distortion
120.0	0.340	40.28	0.9871	4194.0	104.1	12.15

Photometric and Colorimetric Measurements for each lamp

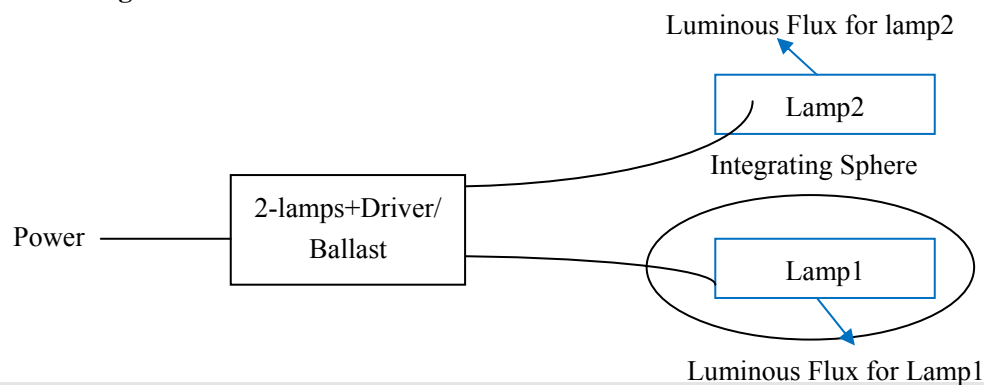
Sample Number	Luminous Flux(lm)	Correlated Color Temperature (K)	Color Rendering Index Ra
1#	2095.0	2956	82.4
2#	2099.0	2965	82.5
Sample Number	Color Rendering Index R9	Chromaticity Coordinate x	Chromaticity Coordinate y
1#	8.1	0.4358	0.3967
2#	8.3	0.4352	0.3966

Table 1: Executive Data Summary

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

Luminous Efficacy= (Luminous Flux for lamp1+ Luminous Flux for lamp2)/Power

Test figure is shown as following:



Test specifications:

Date of Receipt : Apr. 10, 2015

Date of Test : Apr. 10, 2015 to Apr. 13, 2015

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 Photos

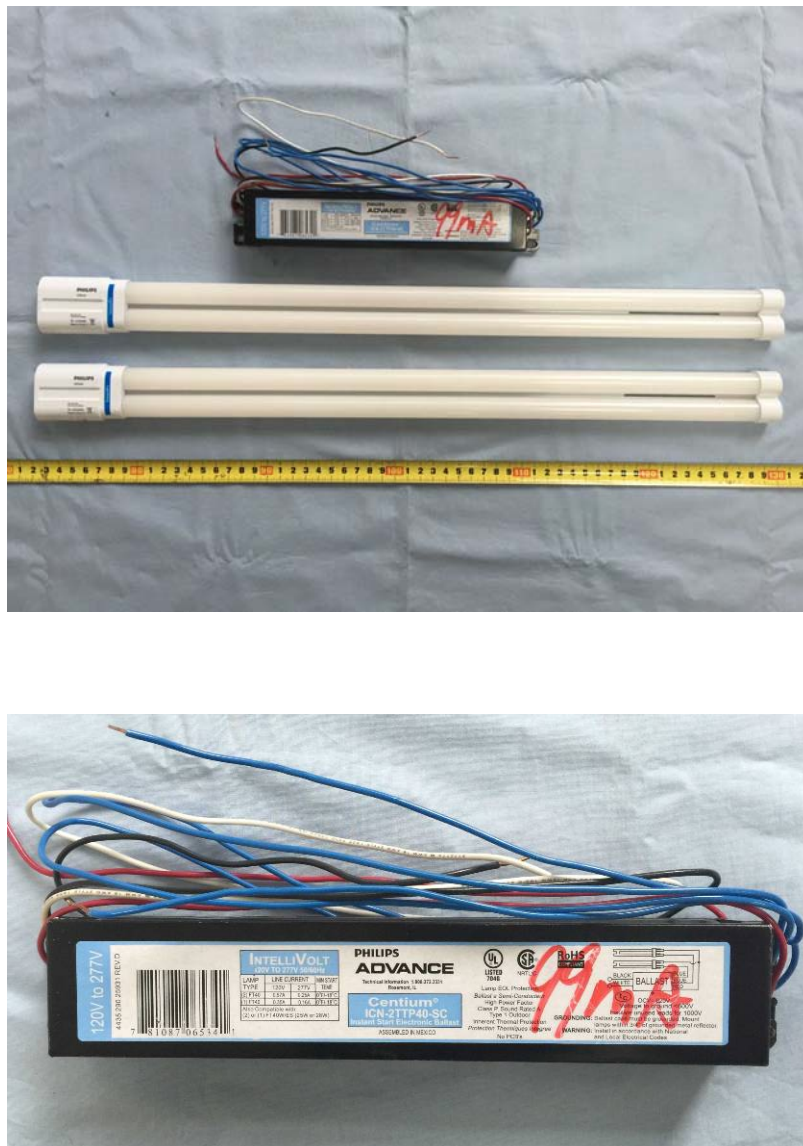


Figure 1- Overview of the sample

Equipment Under Test (EUT)

Name	: InstantFit LEDtube
Model	: 9290011513(2 lamps+ballast ICN-2TTP40-SC)
Electrical Ratings	: 120Vac, 60Hz, 21W
Product Description	: 4 foot fixed ends tube, 3000K, Frosted Lens, 2G11 base LED tubes supplied by a high frequency fluorescent lamp ballast: Centium ICN-2TTP40-SC
Manufacturer	: Philips (China) Investment Co., Ltd.
Address	: Building 9, Lane 888, Tianlin Road Shanghai, China

TEST RESULTS

Test ambient temperature was 24.8°C.

Base orientation was light down. 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	
	1#	2#
Test Voltage (V)	120.0	
Voltage frequency (Hz)	60	
Test Current (A)	0.340	
Power Factor	0.9871	
Test power (W) (ballast + 2 tubes)	40.28	
THD A%	12.15	
Luminous Efficacy (lm/W)	104.1	
Total Luminous Flux (lm)	2095.0	2099.0
Color Rendering Index (CRI)	82.4	82.5
R9	8.1	8.3
Correlated Color Temperature (CCT) (K)	2956	2965
Chromaticity Chroma x	0.4358	0.4352
Chromaticity Chroma y	0.3967	0.3966
Chromaticity Chroma u	0.2531	0.2527
Chromaticity Chroma v	0.3455	0.3454
Duv	0.0030	0.0030
Chromaticity Chroma u'	0.2531	0.2527
Chromaticity Chroma v'	0.5183	0.5181

Special Color Rendering Indices		
	1#	2#
R1	81.5	81.6
R2	92.6	92.7
R3	94.3	94.3
R4	79.4	79.5
R5	82	82
R6	90.9	90.9
R7	80.9	80.9
R8	58	58.1
R9	8.1	8.3
R10	83.1	83.2
R11	78.6	78.6
R12	74.6	74.5
R13	84.4	84.4
R14	97.7	97.7

Table 2: Test data per Sphere-Spectroradiometer Method

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

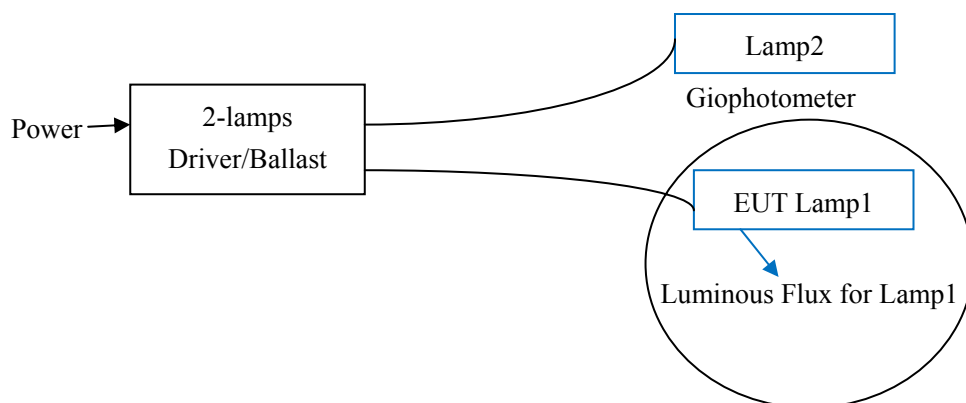
Goniophotometer Method

Test ambient temperature was 24.6°C.

The photometric distance is 30m.

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

Test figure is shown as following:



Note: One lamp was tested in Goniophotometer system. The total electrical input data was recorded before the ballast and divided by 2 in table below to be used as the input data of the tested one lamp.

Parameter	Result
Test Voltage (V)	120.0
Voltage frequency (Hz)	60
Test Current (A)	0.341
Power Factor	0.9870
Test Power (W) (ballast + 2 tubes)/2	20.17
Luminous Efficacy (lm/W)	104.5
Total Luminous Flux (lm) (Single tube)	2107.4
Beam Angle (°)	112.2 (0°-180°)/ 152.5 (90°-270°)
Center Beam Candle Power (cd)	475
Maximum Beam Candle Power (cd)	475.0 (At: C=100.0, Gamma=1.0)
Spacing Criteria	1.26 (0°-180°)/ 1.37 (90°-270°)
Zonal Lumens in the 0°-60°Zone	55.68%
Zonal Lumens in the 60°-90°Zone	26.83%
Zonal Lumens in the 90°-120°Zone	10.79%
Zonal Lumens in the 120°-180°Zone	6.70%

Table 3: Test data per Goniophotometer Method

Spectral Power Distribution of 1# tube - Sphere Spectroradiometer Method

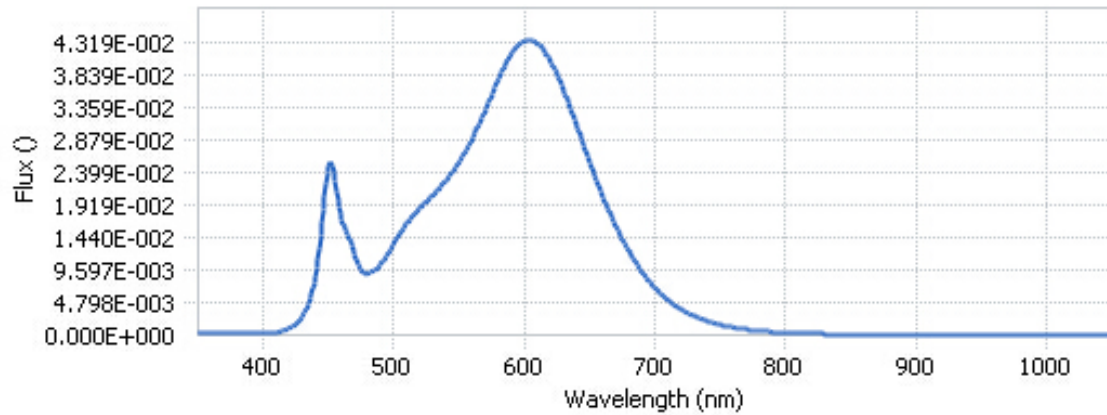
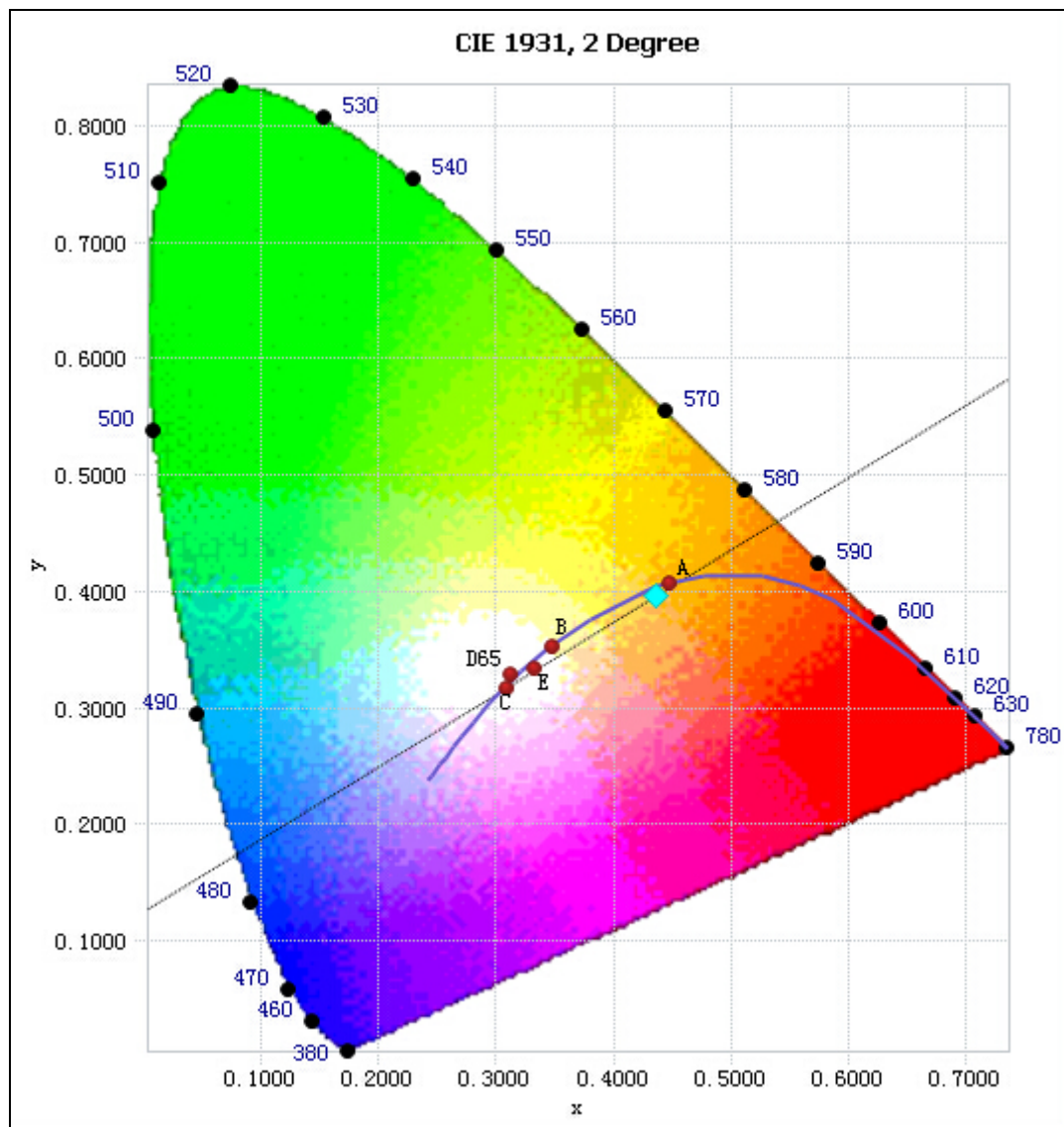


Chart 1: Spectral Power Distribution

Spectral Distribution over Visible Wavelength							
WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)	WL(nm)	Radiant(Watts)
380	2.21E-04	485	9.53E-03	590	4.15E-02	695	8.08E-03
385	2.46E-04	490	1.04E-02	595	4.27E-02	700	6.95E-03
390	2.06E-04	495	1.19E-02	600	4.34E-02	705	5.99E-03
395	1.96E-04	500	1.35E-02	605	4.36E-02	710	5.15E-03
400	2.41E-04	505	1.51E-02	610	4.30E-02	715	4.41E-03
405	2.71E-04	510	1.65E-02	615	4.21E-02	720	3.79E-03
410	3.75E-04	515	1.77E-02	620	4.04E-02	725	3.26E-03
415	6.07E-04	520	1.87E-02	625	3.86E-02	730	2.78E-03
420	1.00E-03	525	1.97E-02	630	3.62E-02	735	2.38E-03
425	1.67E-03	530	2.07E-02	635	3.36E-02	740	2.03E-03
430	2.81E-03	535	2.17E-02	640	3.10E-02	745	1.74E-03
435	4.81E-03	540	2.28E-02	645	2.83E-02	750	1.50E-03
440	8.60E-03	545	2.41E-02	650	2.56E-02	755	1.28E-03
445	1.67E-02	550	2.55E-02	655	2.31E-02	760	1.11E-03
450	2.50E-02	555	2.70E-02	660	2.06E-02	765	9.40E-04
455	2.28E-02	560	2.90E-02	665	1.82E-02	770	8.03E-04
460	1.71E-02	565	3.10E-02	670	1.61E-02	775	6.94E-04
465	1.45E-02	570	3.32E-02	675	1.41E-02	780	5.90E-04
470	1.19E-02	575	3.54E-02	680	1.23E-02		
475	9.52E-03	580	3.77E-02	685	1.07E-02		
480	9.06E-03	585	3.98E-02	690	9.29E-03		

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

Chromaticity Diagram of 1# tube - Sphere Spectroradiometer Method



Tristimulus values(x, y): (0.4358, 0.3967)

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 of 1# tube – Sphere Spectroradiometer Method

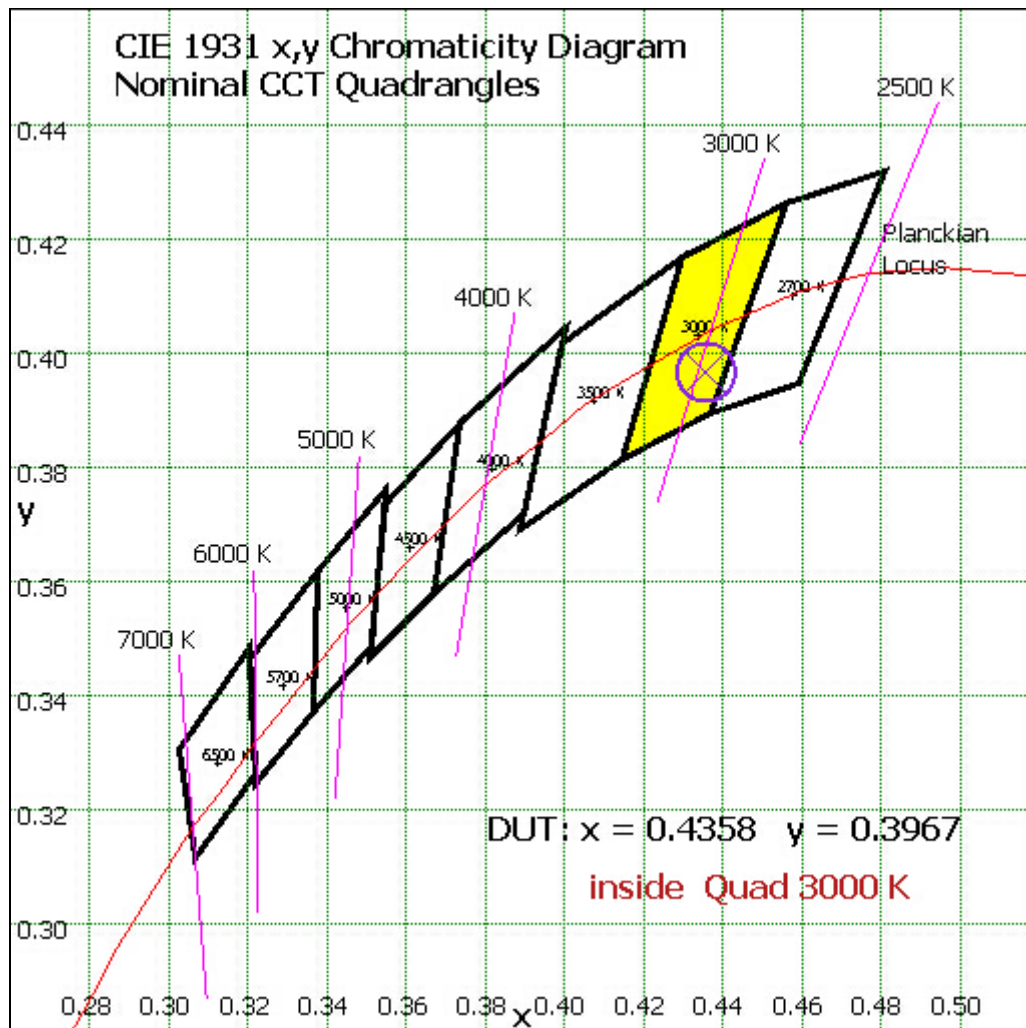


Chart 3: Plot of Lamp x/y coordinates on CIE 1931 Chromaticity Diagram

Zonal Lumen Tabulation- Goniophotometer Method

$\gamma(^{\circ})$	Lumens	% Total
0- 10	44.982	2.13%
10- 20	129.933	6.17%
20- 30	200.726	9.52%
30- 40	250.456	11.88%
40- 50	274.97	13.05%
50- 60	272.425	12.93%
60- 70	243.34	11.55%
70- 80	192.142	9.12%
80- 90	129.899	6.16%
90-100	92.617	4.39%
100-110	75.415	3.58%
110-120	59.459	2.82%
120-130	46.656	2.21%
130-140	36.69	1.74%
140-150	27.358	1.30%
150-160	18.431	0.87%
160-170	9.658	0.46%
170-180	2.289	0.11%
Total	2107.4	100%

$\gamma(^{\circ})$	Lumens	% Total
0- 60	1173.492	55.68%
60- 90	565.381	26.83%
0-90	1738.873	82.51%
90- 180	368.573	17.49%
0- 180	2107.4	100%

Table 5: Zonal Lumen Data

Illuminance Plots- Goniophotometer Method

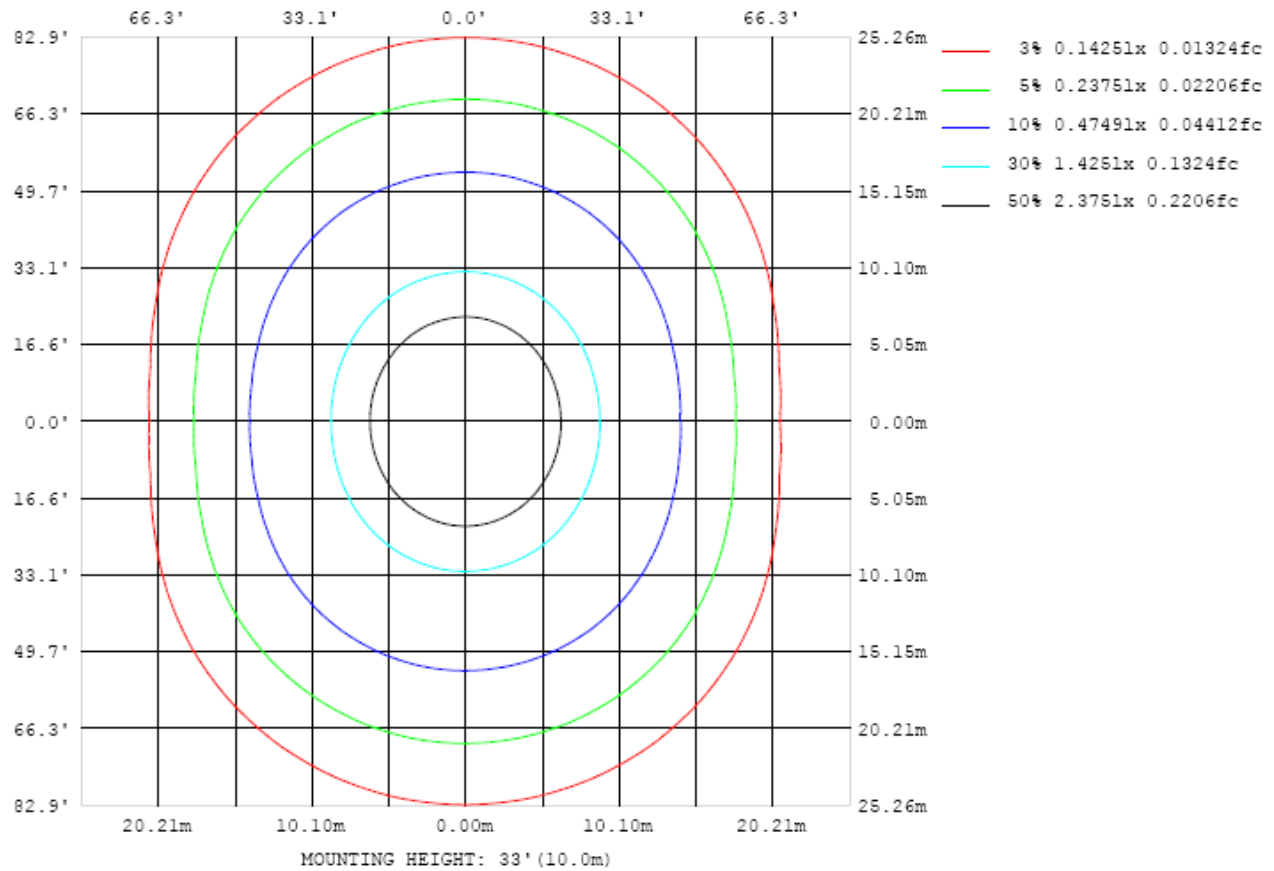


Chart 4: Illuminance Plot (Footcandles)

Luminous Intensity Distribution Plots- Goniophotometer Method

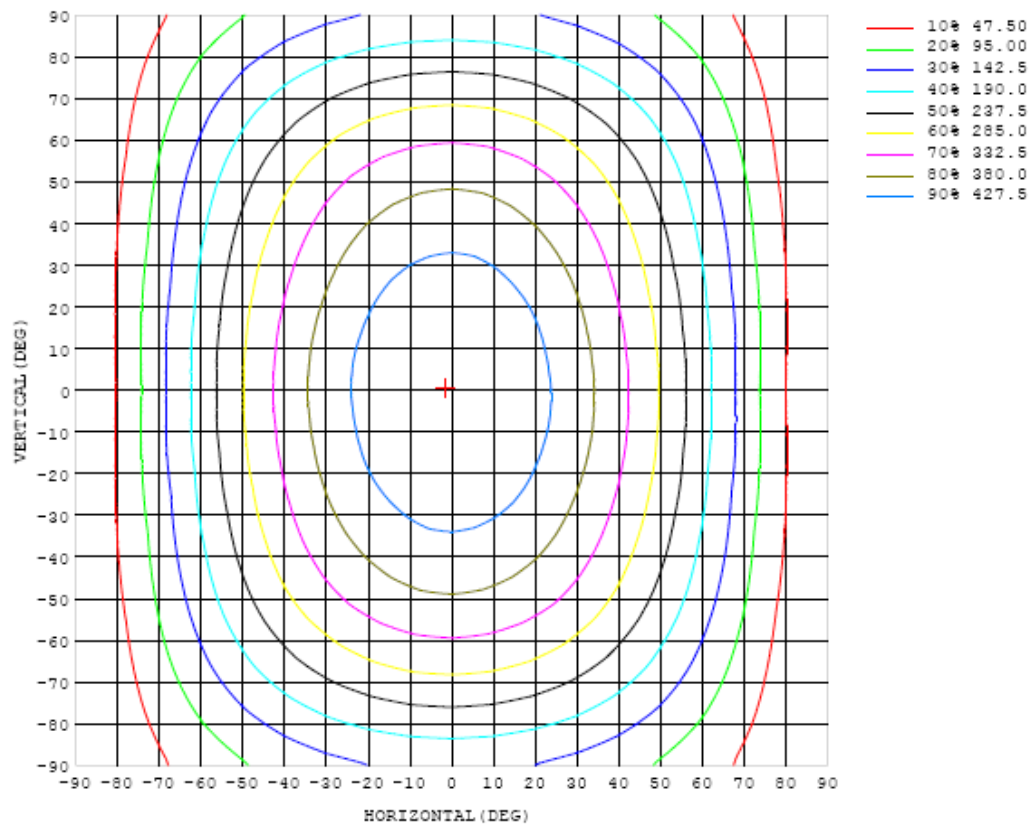


Chart 5: Isocandela Plot

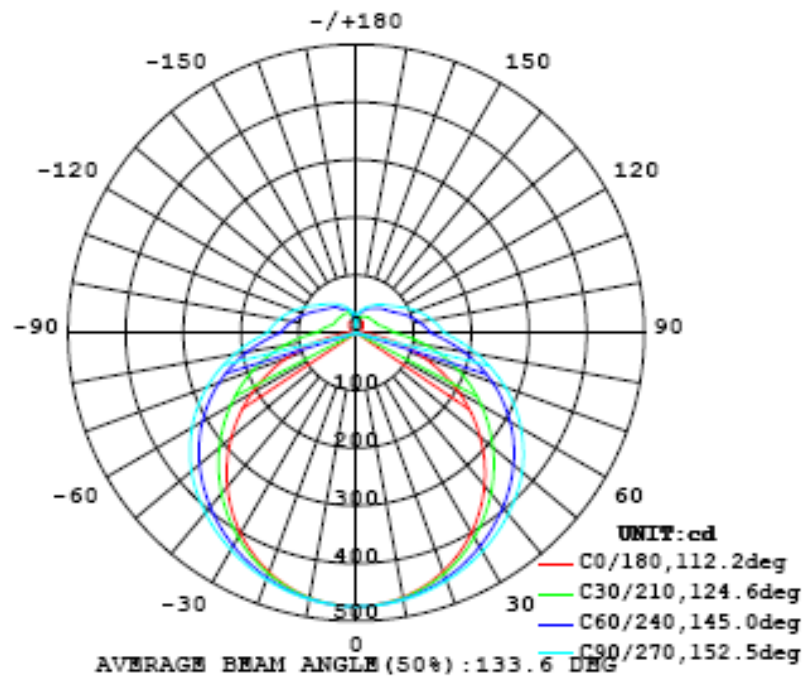


Chart 6: Polar Candela Distribution

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	475	475	475	475	475	475	475	475	475	475	475	475	475	475	475	475	475	475	475
5	472	472	472	473	473	473	473	473	474	474	474	474	473	473	473	473	473	473	473
10	466	466	466	467	468	469	469	470	470	470	470	470	470	469	468	468	467	467	466
15	455	456	456	458	459	461	463	464	465	465	465	464	463	462	460	459	457	456	456
20	440	441	443	445	448	451	453	456	457	458	457	456	454	451	449	446	444	442	442
25	422	423	425	429	433	438	442	445	448	449	448	446	443	439	434	430	427	425	424
30	400	401	405	410	416	423	428	433	436	437	436	434	429	424	417	411	406	403	402
35	375	376	381	388	396	405	413	419	423	425	424	420	414	406	398	390	383	378	377
40	346	348	355	364	375	386	396	404	409	411	409	404	397	387	376	366	357	351	348
45	315	318	326	338	351	365	377	386	392	394	393	387	378	367	353	340	328	320	317
50	281	285	295	310	327	343	356	367	374	376	374	368	358	344	329	312	297	287	283
55	244	249	262	281	300	319	334	345	352	354	352	346	335	321	302	283	265	252	247
60	206	212	229	251	273	293	308	320	327	330	328	321	310	295	275	253	231	215	209
65	166	174	195	220	244	264	281	294	301	304	302	294	282	266	246	223	198	177	169
70	124	135	161	188	213	235	252	264	272	275	273	265	253	237	216	191	164	138	129
75	83.8	97.7	127	155	182	203	221	233	241	244	242	234	222	205	184	159	130	101	88.3
80	46.6	63.6	92.9	123	149	171	189	202	210	213	210	203	190	173	151	126	97.2	67.2	50.0
85	15.3	33.4	63.5	91.8	118	140	157	170	178	181	179	171	158	141	119	94.1	66.2	37.3	18.9
90	0.37	14.9	40.4	67.7	91.2	113	130	142	150	153	151	143	131	113	92.3	68.5	41.9	16.1	1.24
95	1.05	10.0	33.4	58.9	82.3	103	120	133	141	143	141	133	121	104	83.4	60.3	34.8	11.1	1.72
100	2.36	9.35	27.9	51.8	74.1	94.2	111	123	131	133	131	123	112	95.2	75.3	53.2	29.4	10.2	3.13
105	4.32	8.89	25.1	45.3	66.6	85.2	101	113	120	123	120	113	102	86.4	67.5	46.9	26.3	9.94	5.10
110	6.59	9.79	24.3	41.0	59.2	76.3	91.0	102	109	112	109	103	92.1	77.5	60.6	42.4	25.2	10.9	7.29
115	8.74	10.8	23.6	39.1	53.9	68.3	81.4	91.7	98.2	100	98.5	92.4	82.4	69.3	55.0	40.3	24.7	11.9	9.63
120	10.9	12.1	23.0	37.7	50.8	62.8	73.0	81.7	87.5	89.7	87.9	82.4	74.0	63.9	51.7	38.4	24.8	13.8	11.8
125	13.0	13.5	23.7	36.3	48.8	58.9	67.7	74.2	78.9	80.7	79.2	74.9	68.7	59.7	49.1	37.5	25.8	14.9	14.1
130	15.0	15.3	24.2	35.1	46.2	55.9	63.4	68.8	72.5	73.9	72.7	69.9	64.1	56.3	46.6	36.5	25.9	16.7	16.3
135	17.2	16.1	24.6	34.5	44.2	52.8	59.6	64.7	67.7	68.6	67.9	65.1	60.1	53.0	45.1	36.2	27.0	18.1	18.2
140	18.9	17.1	25.2	34.4	42.4	50.0	55.9	60.2	62.9	63.9	63.1	60.5	56.4	50.5	43.3	35.7	28.1	18.2	20.1
145	20.2	18.9	25.5	33.4	41.0	47.0	52.2	56.2	58.4	59.2	58.5	56.3	52.6	47.5	42.0	35.9	27.3	19.9	21.6
150	22.3	21.7	26.2	32.4	39.5	44.7	48.8	51.9	53.7	54.4	53.7	51.8	49.0	45.3	41.0	35.2	27.6	20.9	22.3
155	23.2	23.4	26.0	31.5	36.9	42.3	46.0	48.3	49.6	50.0	49.5	48.3	46.2	43.3	39.0	32.7	26.6	21.9	22.1
160	22.2	22.2	25.8	31.4	35.5	39.1	42.1	44.6	45.8	46.2	45.8	44.9	43.1	39.9	35.7	30.8	26.9	21.6	21.9
165	21.4	20.9	22.6	28.1	34.3	36.2	39.0	40.7	41.7	42.3	42.1	41.6	39.8	34.8	29.0	24.6	22.2	19.8	21.6
170	20.2	20.3	19.6	21.2	27.2	32.2	35.4	36.7	37.3	37.9	37.8	36.3	28.9	22.2	19.4	19.3	19.3	19.6	20.7
175	19.7	19.8	19.4	19.5	20.1	20.6	23.3	28.1	29.7	25.8	19.1	16.9	17.8	18.0	18.3	19.4	19.3	19.3	19.9
180	27.2	27.0	26.5	25.2	22.5	19.0	14.3	11.4	8.05	0.82	9.35	11.1	15.0	19.0	21.8	25.3	27.4	28.4	27.2

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	475	475	475	475	475	475	475	475	475	475	475	475	475	475	475	475	475		
5	472	473	473	473	473	473	473	473	473	473	473	473	473	472	472	472	472		
10	466	467	467	468	468	469	469	469	469	469	469	468	468	467	466	466	466		
15	456	457	458	459	460	462	463	463	463	463	462	461	460	458	457	456	455		
20	442	443	445	447	450	452	454	455	456	455	454	452	449	446	444	442	441		
25	424	426	429	433	437	440	444	445	446	445	443	440	436	431	428	424	422		
30	402	405	410	415	421	427	431	434	435	434	431	426	420	414	408	404	401		
35	378	382	388	396	404	411	417	421	422	421	417	410	402	394	386	380	376		
40	350	355	364	374	385	394	402	406	408	406	401	393	383	372	362	353	348		
45	319	327	338	351	364	376	384	390	391	389	383	374	362	349	335	324	317		
50	286	296	310	326	342	355	365	371	373	371	364	354	340	324	308	293	284		
55	251	264	281	300	318	333	344	350	352	350	343	331	316	298	279	261	248		
60	215	230	252	273	293	308	320	327	329	326	319	306	290	271	248	227	212		
65	177	197	222	245	265	282	294	301	304	301	293	280	263	242	218	193	173		
70	139	163	190	215	236	253	266	273	276	273	265	251	234	212	187	159	136		
75	102	131	159	184	206	223	236	243	246	243	235	221	203	181	155	127	98.3		
80	68.0	98.2	128	153	174	192	205	212	215	212	203	190	172	150	124	94.2	64.0		
85	38.1	67.6	96.3	122	144	161	173	181	184	180	172	159	141	119	92.9	63.9	34.4		
90	16.8	42.7	69.4	93.9	115	132	145	154	154	154	144	131	113	91.8	67.1	40.3	14.8		
95	11.7	35.7	61.3	85.2	106	123	135	143	145	142	135	122	104	83.1	59.1	33.4	9.92		
100	10.4	30.3	54.4	77.3	97.4	114	126	133	136	133	125	112	95.5	75.1	52.1	28.1	10.2		
105	12.7	26.9	48.2	69.5	88.6	104	116	123	125	122	115	103	86.7	67.3	45.9	25.8	11.9		
110	14.7	26.7	43.3	62.4	80.0	94.7	106	112	114	112	105	93.2	78.1	60.3	41.9	26.5	13.9		
115	16.8	28.0	40.9	56.4	71.9	85.3	95.4	102	103	101	94.4	83.8	70.1	55.2	40.7	27.2	16.3		
120	19.2	29.1	40.6	52.7	65.4	76.6	85.6	91.1	92.8	90.6	84.6	75.4	64.3	52.4	40.1	28.1	18.9		
125	21.7	30.1	40.6	51.0	60.9	70.2	77.5	82.0	83.4	81.7	76.9	69.6	60.5	50.5	39.7	29.2	21.0		
130	23.8	30.6	39.3	49.5	58.2	65.5	71.4	75.1	76.3	75.0	71.2	65.3	57.6	48.6	39.3	30.6	22.9		
135	25.7	31.9	38.7	46.3	55.5	62.0	66.8	69.8	70.7	69.7	66.6	61.4	54.6	47.0	39.1	31.9	24.7		
140	27.7	33.2	38.8	44.6	50.4	58.2	62.5	65.0	65.7	64.7	61.9	57.6	51.9	45.3	39.2	33.4	26.0		
145	29.1	34.3	38.8	43.5	47.7	53.4	58.2	60.2	60.8	59.9	57.7	53.9	49.2	44.2	39.3	34.5	27.8		
150	29.4	35.0	38.6	42.4	45.7	47.8	52.3	55.3	55.8	55.1	53.3	50.5	47.0	43.3	39.7	35.4	29.1		
155	29.0	35.2	38.3	41.2	43.8	45.7	43.6	50.2	51.4	51.0	49.7	47.8	45.3	42.7	40.0	36.1	30.7		
160	25.9	33.2	37.7	40.0	41.9	43.3	43.7	43.1	46.5	47.5	46.7	45.4	43.9	42.2	40.0	36.5	29.6		
165	21.9	25.1	29.1	32.9	37.6	41.2	41.6	40.7	41.2	42.5	43.9	43.3	42.6	41.3	38.3	30.7	26.3		
170	20.8	21.1	21.8	22.7	24.3	27.1	34.8	39.1	37.7	38.2	38.9	39.9	38.8	36.3	29.2	22.9	21.3		
175	19.9	20.0	20.0	20.4	20.0	19.9	19.8	19.3	21.7	27.4	28.2	27.1	22.8	20.0	20.4	19.5	19.3		
180	27.1	26.9	26.2	24.9	22.6	19.3	15.1	11.9	9.60	2.39	8.86	12.4	15.4	19.1	21.9	25.4	27.2		

Table 7: Luminous Intensity Data

EQUIPMENT LIST

Test Equipment	Model	Equipment No.	Calibration Date	Calibration Due date
Goniophotometer system	GO-R5000	HZTE011-01	Sep. 18, 2014	Sep. 17, 2015
Digital Power Meter	PF2010A	HZTE028-01	Sep. 18, 2014	Sep. 17, 2015
AC Power Supply	PCR 500L	HZTE001-08	Sep. 18, 2014	Sep. 17, 2015
DC Power Supply	WY12010	HZTE004-03	Sep. 18, 2014	Sep. 17, 2015
Temperature Meter	TES1310	HZTE017-01	Sep. 18, 2014	Sep. 17, 2015
Standard source	D908	HZTE012-01	Sep. 18, 2014	Sep. 17, 2015
Integrate Sphere system	2M	HZTE015-01	Sep. 18, 2014	Sep. 17, 2015
Digital Power Meter	WT210	HZTE008-01	Sep. 18, 2014	Sep. 17, 2015
AC Power Supply	PCR 500L	HZTE001-07	Sep. 18, 2014	Sep. 17, 2015
DC Power Supply	6154	HZTE004-04	Sep. 18, 2014	Sep. 17, 2015
Temperature and humidity recorder	JR900	HZTE018-01	Sep. 18, 2014	Sep. 17, 2015
Standard source	SCL-1400	HZTE012-02	Sep. 18, 2014	Sep. 17, 2015
Fluorescent Ballast Analyzer	HB-6B	HZTE002-01	Sep. 18, 2014	Sep. 17, 2015

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 expended 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

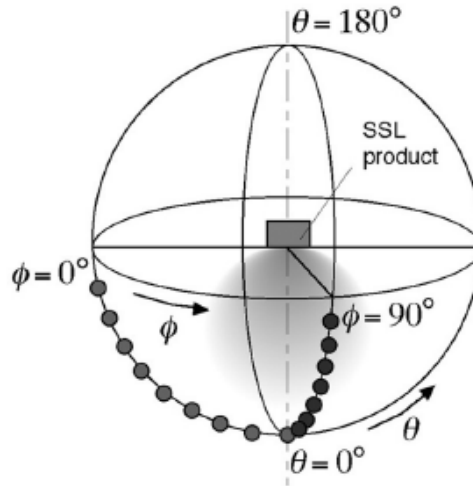
The color characteristics of SSL products include chromaticity coordinates, correlated color temperature, and color rendering index. These characteristics of SSL products may be spatially non-uniform, and thus, in order that they can be specified accurately, the color quantities shall be measured as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