



# IESNA LM-80-2008

MEASURING LUMEN MAINTENANCE OF LED LIGHT SOURCES

## MEASUREMENT AND TEST REPORT

For

**Guangzhou Hongli Opto-Electronic Co., Ltd.**

No.1, Xianke Yi Road, Huadong Town, Huadu District, Guangzhou, China

**Model:HL-A-4014HW-S1-HR3-DM**

<b>Report Type:</b> 9000 Hours Test Report	<b>Product Type:</b> LED Package
<b>Test Engineer:</b> Daniel Duan	<i>Daniel Duan</i>
<b>Report Number:</b> RSZ140110505-10-9000	
<b>Test Date:</b> 2014-02-01 to 2015-10-07	
<b>Report Date:</b> 2015-10-14	
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**Note:** The test data was only valid for the test sample(s). This test report is prepared for the customer shown above and for the device described herein. It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. (Dongguan).

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## 1 - GENERAL INFORMATION

### 1.1 Description of LED Light Sources

Devices tested

Part Number: HL-A-4014HW-S1-HR3-DM  
 Part Type: LED Package  
 Nominal CCT: 2700K

### 1.2 Standards Used:

- IESNA LM-80-08: IES Approved Method for Measuring Lumen Maintenance of LED Light Sources.
- ENERGY STAR® Program Guidance Regarding LED Package, LED Array and LED Module Lumen Maintenance Performance Data Supporting Qualification of Lighting Products(This test method was not accredited by IAS)

### 1.3 Test Facility

The testing facility used by Bay Area Compliance Laboratories Corp. (Dongguan). is located at Pu Long Cun 69, Puxinghu Industrial Area, Tangxia Town, Dongguan, Guangdong, P.R.China.

### 1.4 Description of Auxiliary Equipment

Device	Manufacture	Model No	Serial No	Test Range	Calibration date	Calibration due date
Integral Sphere	EVERFINE	Diameter 0.3m	1011119	380-780nm, Diameter:0.3m,0-1999Lumen	2015-03-04	2016-03-04
Programmable Test Power for LEDs	EVERFINE	LED300E	1008002	15V/2000mA	2015-03-12	2016-03-12
High accuracy array spectroradiometer	EVERFINE	HAAS-2000	1012016T	380-780nm	2014-12-26	2015-12-26
Standard Light Source	EVERFINE	D062	1011093	N/A	2015-05-06	2016-05-06
Precision digital stabilized DC power supply	EVERFINE	WY605	G115987CJ 7321114	300VA	2015-03-12	2016-03-12
Multilayen aging machine	BACL	B2-270	8/Oct/54	N/A	2015-08-11	2016-08-11
Adjustable constant-current DC switching power supply	GOTER	WYG-5V40A	1#	0~5V,0~40A	2015-03-12	2016-03-12
Adjustable constant-current DC switching power supply	GOTER	WYG-5V40A	2#	0~5V,0~40A	2015-03-12	2016-03-12
Adjustable constant-current DC switching power supply	GOTER	LLA120011 2-U	2012082001	0~5V,0~40A	2014-12-31	2015-12-31

## 1.5 Operating Cycle

Samples are driven with a constant direct current (DC)

## 1.6 Ambient Conditions

For lumen maintenance test, samples were operated in thermal chambers with minimal ambient airflow. For long term reliability test, the case temperature was controlled by mounting several thermocouples on a sample reliability stress board at the designated thermal measurement point, as shown in APPENDIX. The ambient temperature  $T_A$  was measured by several thermocouples at a distance of 5 mm above the reliability test board. The relative humidity within chamber was less than 65%.

For photometry measurement, temperature was set to  $25\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ , RH <65%.

## 1.7 Photometry Measurement Uncertainty

The uncertainty of the light output measurements is  $U=1.59\%$  ( $K=2$ ), at the 95% confidence level. The uncertainty of the correlated color temperature measurements is  $U=21\text{K}$  ( $K=2$ ), at the 95% confidence level. This calibration results traceable to the NATIONAL INSTITUTE OF METROLOGY (NIM).

## 1.8 Sample Set

### Sampling Method:

LED samples for IESNA LM-80 testing consist of units built from a minimum of three manufacturing lots with each manufacturing lot built from different wafer lots built on non-consecutive days.

These manufacturing lots are picked to represent a wide parametric distribution.

Each Sample is soldered to all of the reliability stress boards for a given set of IESNA LM-80 tests.

### Sample Size:

Total 75Pcs;

Each Ts test condition 25Pcs

The samples tested at Ts 55 °C, 85 °C and Ts 105 °C were received at 2014-01-10 and tested during 2014-02-01 to 2015-10-07. The samples were numbered from 1 to 25, 26 to 50 and 51 to 75

#### Data Set 1: 55 °C, 60mA

Part Number:	HL-A-4014HW-S1-HR3-DM
Number of Units:	25
Actual Case Temperature(T <sub>S</sub> ):	T <sub>S</sub> =53.9 °C
Actual Ambient Temperature(T <sub>A</sub> ):	T <sub>A</sub> =51.8 °C
Life Test Drive Current:	I <sub>F</sub> = 60mA
Measurement Current:	I <sub>F</sub> = 60mA

#### Data Set 2: 85 °C,60mA

Part Number:	HL-A-4014HW-S1-HR3-DM
Number of Units:	25
Actual Case Temperature(T <sub>S</sub> ):	T <sub>S</sub> =84.2 °C
Actual Ambient Temperature(T <sub>A</sub> ):	T <sub>A</sub> =82.3 °C
Life Test Drive Current:	I <sub>F</sub> =60mA
Measurement Current:	I <sub>F</sub> = 60mA

#### Data Set 3: 105 °C, 60mA

Part Number:	HL-A-4014HW-S1-HR3-DM
Number of Units:	25
Actual Case Temperature(T <sub>S</sub> ):	T <sub>S</sub> =104.1 °C
Actual Ambient Temperature(T <sub>A</sub> ):	T <sub>A</sub> =103.4 °C
Life Test Drive Current:	I <sub>F</sub> = 60mA
Measurement Current:	I <sub>F</sub> = 60mA

## 2 - SUMMARY OF TEST RESULT

<b>Data Set:</b>	<b>Data Set 1, 55 °C, 60mA</b>
Number of Units:	25
Failures Observed:	0
Test Interval and Test Duration:	0h,1000h,2000h,3000h,4000h,5000h,6000h,7000h,8000h,9000h
Average. Lumen Maintenance at 6000 hours:	97.56%
Average. Lumen Maintenance at 9000 hours:	96.07%
Average Chromaticity Shift at 6000 hours ( $\Delta u'v'$ ):	0.0020
Average Chromaticity Shift at 9000 hours ( $\Delta u'v'$ ):	0.0033
Reported TM-21 L <sub>70</sub> Lifetime:	>54,000 hours

<b>Data Set:</b>	<b>Data Set 2, 85 °C, 60mA</b>
Number of Units:	25
Failures Observed:	0
Test Interval and Test Duration:	0h,1000h,2000h,3000h,4000h,5000h,6000h,7000h,8000h,9000h
Average. Lumen Maintenance at 6000 hours:	97.24%
Average. Lumen Maintenance at 9000 hours:	95.19%
Average Chromaticity Shift at 6000 hours( $\Delta u'v'$ ):	0.0024
Average Chromaticity Shift at 9000 hours ( $\Delta u'v'$ ):	0.0036
Reported TM-21 L <sub>70</sub> Lifetime:	53,000 hours

<b>Data Set:</b>	<b>Data Set 3, 105 °C, 60Ma</b>
Number of Units:	25
Failures Observed:	0
Test Interval and Test Duration:	0h,1000h,2000h,3000h,4000h,5000h,6000h,7000h,8000h,9000h
Average. Lumen Maintenance at 6000 hours:	96.88%
Average. Lumen Maintenance at 9000 hours:	94.35%
Average Chromaticity Shift at 6000 hours( $\Delta u'v'$ ):	0.0027
Average Chromaticity Shift at 9000 hours ( $\Delta u'v'$ ):	0.0037
Reported TM-21 L <sub>70</sub> Lifetime:	46,000 hours

### 3 - Test Data

#### 3.1 Data Set 1, 55 °C, 60mA (Lumen Maintenance)

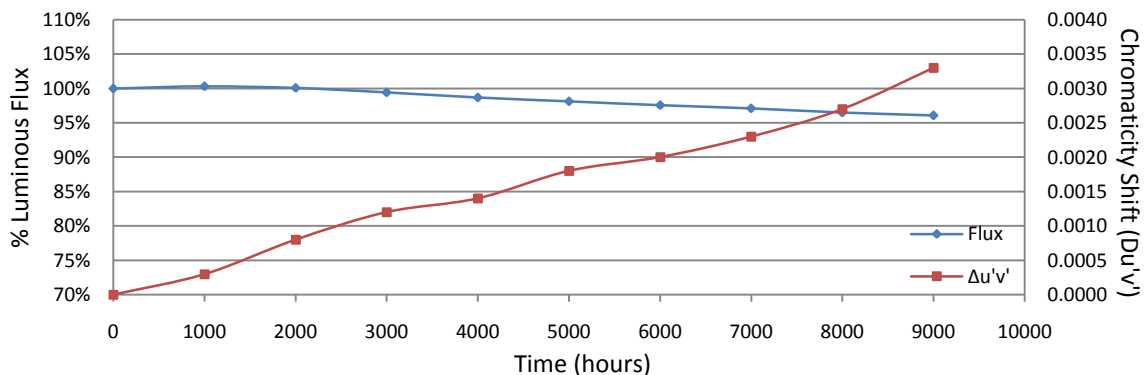
No.	V <sub>F</sub> (V)	Φ(lm)	Lumen Maintenance (%)								
	Ohr(Initial)		1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs
1	3.031	17.76	99.94	99.61	98.99	98.14	97.47	96.79	96.40	95.95	95.44
2	3.026	17.23	100.41	100.17	99.54	98.84	98.37	97.74	97.16	96.92	96.29
3	3.029	17.35	100.23	100.00	99.37	98.62	98.10	97.58	97.23	96.89	96.54
4	3.018	17.63	100.06	99.66	99.04	98.24	97.62	96.94	96.71	95.97	95.35
5	3.027	17.93	100.50	100.22	99.61	99.05	98.44	97.94	97.60	97.27	96.99
6	3.033	18.10	100.39	100.17	99.45	98.90	98.34	97.73	97.07	96.41	96.08
7	3.027	17.79	101.12	100.84	100.17	99.55	98.99	98.59	97.92	97.13	96.74
8	3.012	17.66	100.40	100.17	99.55	98.81	98.19	97.57	97.45	97.23	96.89
9	3.027	17.88	100.17	100.00	99.33	98.66	98.04	97.48	96.87	96.36	95.69
10	3.030	17.83	100.34	100.06	99.38	98.54	97.92	97.36	96.69	96.19	95.85
11	3.028	18.06	100.33	100.06	99.45	98.62	98.06	97.45	97.01	96.84	96.68
12	3.013	18.12	99.94	99.67	99.06	98.23	97.52	97.02	96.80	96.69	96.25
13	3.018	18.02	100.39	100.17	99.56	98.89	98.45	97.95	97.56	97.11	96.67
14	3.029	17.75	100.00	99.77	99.04	98.31	97.69	97.13	96.73	95.61	95.49
15	3.013	17.87	99.83	99.55	98.94	98.10	97.48	96.92	96.53	96.08	95.69
16	3.026	17.99	100.56	100.33	99.72	99.11	98.50	98.05	97.61	97.11	96.83
17	3.022	18.14	100.00	99.78	99.12	98.35	97.68	97.13	96.64	96.09	95.31
18	3.013	17.51	99.60	99.37	98.74	97.89	97.43	96.80	96.40	95.95	95.43
19	3.016	17.75	99.83	99.61	98.99	98.20	97.52	97.01	96.62	95.49	95.21
20	3.029	17.74	101.52	101.24	100.56	100.06	99.61	98.99	98.53	98.08	97.80
21	3.007	18.07	100.22	100.00	99.39	98.62	97.90	97.40	96.62	95.52	95.13
22	3.029	17.53	100.80	100.57	99.94	99.09	98.46	98.23	97.89	97.26	96.69
23	3.012	18.13	99.94	99.78	99.12	98.46	98.01	97.57	96.69	95.53	95.26
24	3.025	18.12	100.00	99.78	99.12	98.57	97.85	97.30	96.63	96.47	95.70
25	3.025	17.92	101.23	100.95	100.28	99.44	98.94	98.33	97.71	96.71	95.70
Ave.	3.023	17.84	100.31	100.06	99.42	98.69	98.10	97.56	97.08	96.51	96.07
Med.	3.026	17.87	100.23	100.00	99.38	98.62	98.04	97.48	96.87	96.47	95.85
st dev	0.0075	0.2500	0.4605	0.4560	0.4486	0.5032	0.5421	0.5705	0.5612	0.6756	0.7093
Min.	3.007	17.23	99.60	99.37	98.74	97.89	97.43	96.79	96.40	95.49	95.13
Max.	3.033	18.14	101.52	101.24	100.56	100.06	99.61	98.99	98.53	98.08	97.80

TM-21 Projection:

**Test Duration:** 9000 hours  
**Failures Observed:** 0  
 $\alpha$ : 5.385E-06  
 $\beta$ : 1.008  
**Calculated L<sub>70</sub>:** 68,000hours  
**Reported L<sub>70</sub>:** >54,000hours

### 3.2 Data Set 1, 55 °C, 60mA (Chromaticity Shift)

No.	u'	v'	CCT(K)	Chromaticity Shift ( $\Delta u'v'$ )								
	0hr(Initial)			1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs
1	0.2629	0.5282	2688	0.0001	0.0007	0.0010	0.0013	0.0013	0.0015	0.0018	0.0022	0.0027
2	0.2608	0.5282	2731	0.0003	0.0007	0.0011	0.0012	0.0016	0.0019	0.0023	0.0027	0.0032
3	0.2636	0.5270	2678	0.0000	0.0006	0.0009	0.0011	0.0014	0.0015	0.0018	0.0020	0.0024
4	0.2593	0.5268	2771	0.0001	0.0007	0.0011	0.0013	0.0017	0.0021	0.0023	0.0026	0.0040
5	0.2579	0.5243	2813	0.0000	0.0006	0.0014	0.0015	0.0017	0.0020	0.0022	0.0030	0.0046
6	0.2608	0.5281	2732	0.0002	0.0007	0.0013	0.0014	0.0019	0.0021	0.0024	0.0028	0.0038
7	0.2587	0.5286	2774	0.0004	0.0008	0.0012	0.0016	0.0018	0.0019	0.0022	0.0020	0.0024
8	0.2591	0.5262	2777	0.0005	0.0008	0.0012	0.0016	0.0018	0.0021	0.0022	0.0028	0.0035
9	0.2626	0.5260	2704	0.0004	0.0006	0.0011	0.0014	0.0016	0.0018	0.0022	0.0026	0.0030
10	0.2576	0.5225	2828	0.0002	0.0008	0.0012	0.0014	0.0017	0.0021	0.0024	0.0028	0.0031
11	0.2600	0.5269	2755	0.0006	0.0006	0.0015	0.0015	0.0016	0.0020	0.0023	0.0036	0.0039
12	0.2592	0.5283	2766	0.0003	0.0005	0.0010	0.0013	0.0014	0.0017	0.0019	0.0018	0.0028
13	0.2596	0.5262	2766	0.0004	0.0009	0.0010	0.0015	0.0020	0.0023	0.0026	0.0028	0.0027
14	0.2628	0.5276	2693	0.0004	0.0009	0.0014	0.0014	0.0018	0.0021	0.0024	0.0023	0.0034
15	0.2602	0.5272	2749	0.0002	0.0007	0.0013	0.0015	0.0020	0.0022	0.0027	0.0032	0.0035
16	0.2566	0.5266	2831	0.0004	0.0009	0.0013	0.0015	0.0018	0.0023	0.0026	0.0028	0.0040
17	0.2605	0.5282	2737	0.0003	0.0009	0.0012	0.0012	0.0016	0.0019	0.0023	0.0023	0.0033
18	0.2594	0.5246	2777	0.0005	0.0010	0.0015	0.0016	0.0020	0.0022	0.0026	0.0029	0.0034
19	0.2584	0.5265	2791	0.0004	0.0007	0.0011	0.0016	0.0018	0.0021	0.0024	0.0027	0.0032
20	0.2599	0.5241	2770	0.0002	0.0006	0.0014	0.0016	0.0019	0.0022	0.0024	0.0031	0.0039
21	0.2582	0.5268	2793	0.0000	0.0008	0.0014	0.0014	0.0018	0.0020	0.0024	0.0030	0.0034
22	0.2600	0.5251	2761	0.0003	0.0011	0.0015	0.0015	0.0020	0.0024	0.0027	0.0030	0.0024
23	0.2602	0.5286	2744	0.0001	0.0007	0.0013	0.0014	0.0018	0.0023	0.0028	0.0033	0.0034
24	0.2630	0.5286	2685	0.0002	0.0008	0.0013	0.0015	0.0018	0.0020	0.0022	0.0024	0.0031
25	0.2636	0.5295	2669	0.0002	0.0006	0.0011	0.0013	0.0017	0.0020	0.0023	0.0026	0.0031
Ave.	0.2602	0.5268	2751	0.0003	0.0008	0.0012	0.0014	0.0018	0.0020	0.0023	0.0027	0.0033
Med.	0.2600	0.5269	2761	0.0003	0.0007	0.0012	0.0014	0.0018	0.0021	0.0023	0.0028	0.0033
st dev	0.0019	0.0017	45.5080	0.0002	0.0001	0.0002	0.0001	0.0002	0.0002	0.0003	0.0004	0.0005
Min.	0.2566	0.5225	2669	0.0000	0.0005	0.0009	0.0011	0.0013	0.0015	0.0018	0.0018	0.0024
Max.	0.2636	0.5295	2831	0.0006	0.0011	0.0015	0.0016	0.0020	0.0024	0.0028	0.0036	0.0046





**3.3 Data Set 2, 85 °C, 60mA (Lumen Maintenance)**

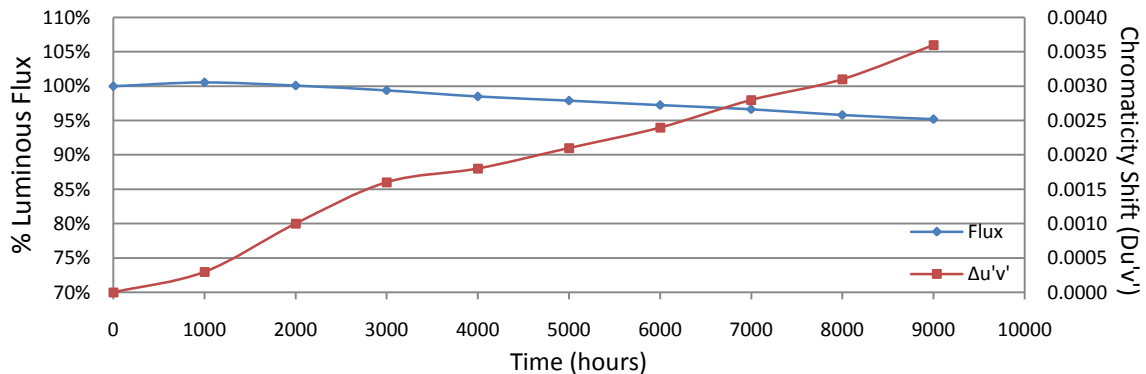
No.	V <sub>F</sub> (V)	Φ(lm)	Lumen Maintenance (%)								
			0hr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs
26	3.011	17.88	100.00	99.50	98.88	98.15	97.43	96.70	96.03	95.25	94.63
27	3.006	18.20	100.33	99.95	99.23	98.46	97.86	97.42	97.14	96.26	95.55
28	3.029	17.77	100.90	100.39	99.77	98.93	98.31	97.69	96.68	95.72	94.94
29	3.008	17.97	99.94	99.44	98.72	97.66	96.99	96.33	95.55	94.60	93.99
30	3.029	17.49	100.40	99.94	99.26	98.28	97.60	96.97	96.23	95.14	94.28
31	3.030	17.80	99.94	99.49	98.82	97.92	97.30	96.57	96.46	96.01	95.34
32	3.019	17.40	101.03	100.57	99.83	99.20	98.62	98.05	97.47	96.84	96.38
33	3.034	17.20	101.22	100.81	100.17	99.48	98.95	98.37	97.91	97.15	96.63
34	3.020	18.07	100.55	100.17	99.45	98.62	98.17	97.51	96.96	96.07	95.30
35	3.027	17.37	100.23	99.77	99.02	97.99	97.24	96.55	95.39	94.36	93.49
36	3.012	17.30	100.17	99.77	99.02	98.09	97.28	96.59	95.72	95.32	94.86
37	3.032	18.44	100.38	100.00	99.35	98.54	97.89	97.23	96.96	96.64	96.53
38	3.028	17.73	100.06	99.66	98.93	97.97	97.35	96.62	95.94	94.75	94.19
39	3.030	17.88	101.68	101.29	100.56	99.38	98.94	98.38	98.04	97.20	96.53
40	3.024	18.48	99.84	99.46	98.70	97.84	97.13	96.43	95.56	94.37	93.45
41	3.027	18.18	99.94	99.45	98.79	97.91	97.36	96.75	95.82	95.21	95.16
42	3.024	17.56	101.08	100.63	99.89	99.20	98.52	97.84	97.38	96.58	96.13
43	3.025	18.23	100.16	99.67	98.96	97.97	97.26	96.54	95.83	94.90	94.57
44	3.026	18.23	101.54	101.04	100.38	99.67	99.07	98.30	97.75	96.49	96.27
45	3.029	18.11	100.72	100.22	99.61	98.56	97.85	97.18	96.52	96.25	95.64
46	3.018	17.51	100.06	99.66	98.97	97.89	97.14	96.52	95.83	94.23	93.83
47	3.026	17.88	100.17	99.78	99.05	98.15	97.43	96.76	96.31	95.53	95.13
48	3.031	17.66	100.34	99.83	99.09	98.30	97.73	97.11	96.66	96.21	95.92
49	3.022	17.97	101.11	100.61	100.00	99.28	98.78	98.16	97.33	96.22	95.38
50	3.017	18.69	101.44	101.02	100.32	99.20	98.88	98.34	97.97	97.75	95.61
Ave.	3.023	17.88	100.53	100.08	99.39	98.51	97.88	97.24	96.62	95.80	95.19
Med.	3.026	17.88	100.34	99.94	99.23	98.30	97.73	97.11	96.52	96.01	95.30
st dev	0.0077	0.3896	0.5609	0.5602	0.5706	0.6089	0.6814	0.7121	0.8328	0.9718	0.9600
Min.	3.006	17.20	99.84	99.44	98.70	97.66	96.99	96.33	95.39	94.23	93.45
Max.	3.034	18.69	101.68	101.29	100.56	99.67	99.07	98.38	98.04	97.75	96.63

**TM-21 Projection:**

**Test Duration:** 9000 hours  
**Failures Observed:** 0  
**α:** 6.921E-06  
**β:** 1.013  
**Calculated L<sub>70</sub>:** 53,000hours  
**Reported L<sub>70</sub>:** 53,000hours

### 3.4 Data Set 2, 85 °C, 60mA (Chromaticity Shift)

No.	u'	v'	CCT(K)	Chromaticity Shift ( $\Delta u'v'$ )								
				0hr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs
26	0.2633	0.5282	2680	0.0002	0.0007	0.0013	0.0015	0.0016	0.0019	0.0022	0.0029	0.0037
27	0.2635	0.5273	2679	0.0004	0.0008	0.0016	0.0017	0.0019	0.0021	0.0024	0.0029	0.0023
28	0.2607	0.5263	2743	0.0004	0.0010	0.0016	0.0017	0.0019	0.0021	0.0024	0.0026	0.0031
29	0.2613	0.5264	2728	0.0002	0.0011	0.0015	0.0017	0.0020	0.0023	0.0026	0.0030	0.0042
30	0.2623	0.5277	2703	0.0003	0.0014	0.0018	0.0017	0.0021	0.0023	0.0028	0.0032	0.0028
31	0.2607	0.5280	2735	0.0003	0.0011	0.0016	0.0017	0.0022	0.0024	0.0028	0.0031	0.0035
32	0.2591	0.5228	2792	0.0005	0.0012	0.0018	0.0019	0.0022	0.0024	0.0027	0.0030	0.0039
33	0.2607	0.5270	2740	0.0002	0.0011	0.0015	0.0017	0.0021	0.0024	0.0028	0.0031	0.0039
34	0.2621	0.5286	2703	0.0004	0.0008	0.0015	0.0017	0.0020	0.0023	0.0027	0.0031	0.0033
35	0.2603	0.5267	2749	0.0004	0.0013	0.0018	0.0020	0.0023	0.0025	0.0028	0.0032	0.0035
36	0.2614	0.5276	2721	0.0000	0.0010	0.0015	0.0016	0.0020	0.0023	0.0028	0.0032	0.0035
37	0.2600	0.5288	2746	0.0004	0.0009	0.0017	0.0018	0.0021	0.0026	0.0030	0.0035	0.0041
38	0.2614	0.5265	2727	0.0002	0.0010	0.0018	0.0017	0.0019	0.0022	0.0026	0.0029	0.0039
39	0.2609	0.5280	2731	0.0002	0.0009	0.0016	0.0019	0.0021	0.0023	0.0026	0.0029	0.0037
40	0.2605	0.5276	2742	0.0002	0.0012	0.0018	0.0018	0.0021	0.0026	0.0029	0.0031	0.0037
41	0.2604	0.5280	2742	0.0001	0.0009	0.0017	0.0018	0.0020	0.0023	0.0027	0.0030	0.0035
42	0.2613	0.5287	2720	0.0002	0.0009	0.0017	0.0017	0.0022	0.0024	0.0028	0.0032	0.0036
43	0.2598	0.5285	2752	0.0004	0.0010	0.0015	0.0018	0.0022	0.0026	0.0030	0.0034	0.0039
44	0.2586	0.5291	2774	0.0003	0.0010	0.0014	0.0018	0.0023	0.0028	0.0031	0.0034	0.0032
45	0.2618	0.5279	2713	0.0004	0.0011	0.0017	0.0019	0.0020	0.0023	0.0028	0.0032	0.0046
46	0.2620	0.5286	2706	0.0002	0.0010	0.0013	0.0016	0.0020	0.0023	0.0026	0.0028	0.0028
47	0.2611	0.5285	2724	0.0002	0.0012	0.0016	0.0017	0.0022	0.0024	0.0028	0.0032	0.0036
48	0.2607	0.5269	2741	0.0004	0.0009	0.0017	0.0020	0.0023	0.0025	0.0030	0.0034	0.0035
49	0.2595	0.5252	2773	0.0005	0.0011	0.0015	0.0018	0.0023	0.0024	0.0028	0.0033	0.0040
50	0.2611	0.5293	2720	0.0004	0.0009	0.0015	0.0018	0.0024	0.0027	0.0031	0.0035	0.0040
Ave.	0.2610	0.5275	2731	0.0003	0.0010	0.0016	0.0018	0.0021	0.0024	0.0028	0.0031	0.0036
Med.	0.2609	0.5279	2731	0.0003	0.0010	0.0016	0.0017	0.0021	0.0024	0.0028	0.0031	0.0036
st dev	0.0012	0.0014	26.7253	0.0001	0.0002	0.0001	0.0001	0.0002	0.0002	0.0002	0.0002	0.0005
Min.	0.2586	0.5228	2679	0.0000	0.0007	0.0013	0.0015	0.0016	0.0019	0.0022	0.0026	0.0023
Max.	0.2635	0.5293	2792	0.0005	0.0014	0.0018	0.0020	0.0024	0.0028	0.0031	0.0035	0.0046



**3.5 Data Set 3, 105 °C, 60mA (Lumen Maintenance)**

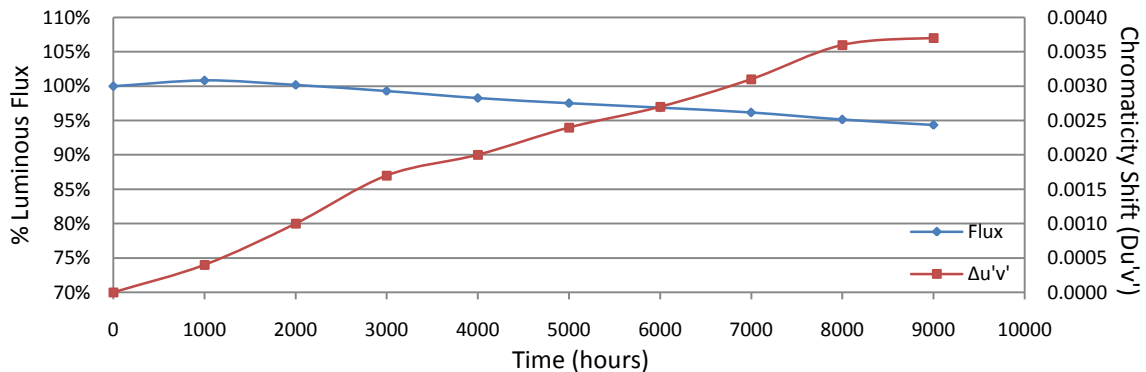
No.	V <sub>F</sub> (V)	Φ(lm)	Lumen Maintenance (%)								
	0hr(Initial)		1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs
51	3.006	18.57	100.54	99.95	99.14	97.95	97.31	96.82	96.07	95.21	94.51
52	3.019	18.08	101.22	100.55	99.72	98.89	97.95	97.35	96.90	95.52	94.91
53	3.014	18.08	100.55	99.94	99.06	97.90	97.23	96.68	96.07	94.80	94.19
54	3.029	17.72	101.30	100.62	99.77	98.76	98.02	97.35	96.39	95.20	94.30
55	3.014	17.99	100.61	100.00	99.06	97.94	97.22	96.72	96.16	95.33	94.83
56	3.028	17.38	100.75	100.06	99.25	98.04	97.41	96.84	96.20	95.22	94.59
57	3.030	17.71	100.79	100.17	99.32	98.19	97.52	96.89	96.16	95.43	94.86
58	3.012	17.33	101.79	101.21	100.29	99.48	98.62	97.81	96.60	95.56	94.69
59	3.033	17.36	100.58	99.94	99.08	97.93	97.29	96.66	95.28	93.78	92.97
60	3.012	17.72	101.13	100.45	99.66	98.76	97.97	97.35	96.95	95.82	95.09
61	3.034	17.98	100.50	99.83	99.00	97.83	97.22	96.55	96.27	95.11	94.22
62	3.019	18.34	100.38	99.78	98.91	97.76	97.06	96.40	95.53	94.49	93.51
63	3.023	17.58	100.34	99.60	98.75	97.55	96.93	96.30	95.79	95.11	94.65
64	3.011	17.76	100.73	100.06	99.16	98.09	97.47	96.85	96.40	95.44	94.14
65	3.024	18.19	100.66	100.00	99.18	98.02	97.42	96.81	96.10	95.99	95.22
66	3.031	18.18	101.27	100.55	99.72	98.95	98.02	97.41	96.42	95.05	94.77
67	3.024	18.06	100.17	99.50	98.67	97.40	96.73	96.12	95.51	94.68	94.30
68	3.026	18.11	100.72	100.06	99.17	98.01	97.40	96.74	95.80	94.98	93.98
69	3.030	17.66	102.04	101.36	100.51	99.66	98.87	98.24	97.28	95.98	94.73
70	3.021	17.89	100.50	99.83	98.94	98.04	97.15	96.53	95.86	94.58	93.63
71	3.032	17.62	100.91	100.23	99.32	98.13	97.45	96.82	95.97	94.84	93.93
72	3.029	18.43	100.81	100.16	99.13	98.59	97.40	96.69	96.31	95.23	94.30
73	3.011	18.28	100.38	99.78	98.85	97.81	96.99	96.39	95.62	95.19	94.37
74	3.020	17.96	100.95	100.33	99.39	98.27	97.61	96.99	96.05	94.60	93.60
75	3.031	17.87	100.78	100.06	99.16	98.04	97.43	96.70	96.19	95.02	94.46
Ave.	3.023	17.91	100.82	100.16	99.29	98.24	97.51	96.88	96.16	95.13	94.35
Med.	3.024	17.96	100.73	100.06	99.16	98.04	97.41	96.81	96.16	95.19	94.37
st dev	0.0083	0.3307	0.4413	0.4407	0.4440	0.5610	0.4975	0.4784	0.4631	0.4909	0.5337
Min.	3.006	17.33	100.17	99.50	98.67	97.40	96.73	96.12	95.28	93.78	92.97
Max.	3.034	18.57	102.04	101.36	100.51	99.66	98.87	98.24	97.28	95.99	95.22

## TM-21 Projection:

**Test Duration:** 9000 hours  
**Failures Observed:** 0  
**α:** 8.103E-06  
**β:** 1.016  
**Calculated L<sub>70</sub>:** 46,000 hours  
**Reported L<sub>70</sub>:** 46,000 hours

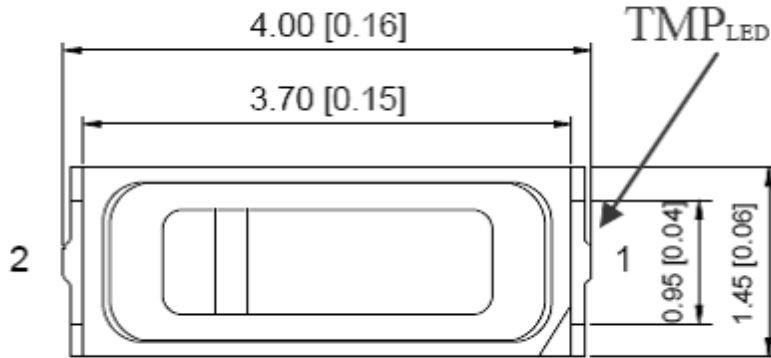
### 3.6 Data Set 3, 105 °C, 60mA (Chromaticity Shift)

No.	u'	v'	CCT(K)	Chromaticity Shift ( $\Delta u'v'$ )								
				0hr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs
51	0.2617	0.5264	2719	0.0006	0.0011	0.0017	0.0020	0.0024	0.0027	0.0031	0.0035	0.0047
52	0.2633	0.5278	2682	0.0005	0.0010	0.0017	0.0021	0.0025	0.0029	0.0033	0.0039	0.0033
53	0.2594	0.5286	2759	0.0004	0.0011	0.0019	0.0021	0.0024	0.0027	0.0031	0.0035	0.0045
54	0.2598	0.5273	2757	0.0004	0.0011	0.0018	0.0024	0.0027	0.0031	0.0035	0.0039	0.0047
55	0.2602	0.5274	2749	0.0003	0.0013	0.0019	0.0020	0.0026	0.0030	0.0035	0.0039	0.0030
56	0.2604	0.5284	2740	0.0006	0.0014	0.0019	0.0021	0.0024	0.0029	0.0034	0.0038	0.0024
57	0.2566	0.5248	2840	0.0003	0.0011	0.0017	0.0019	0.0024	0.0026	0.0030	0.0034	0.0032
58	0.2603	0.5285	2740	0.0002	0.0011	0.0017	0.0020	0.0026	0.0029	0.0032	0.0036	0.0034
59	0.2612	0.5280	2724	0.0002	0.0011	0.0018	0.0018	0.0022	0.0025	0.0028	0.0032	0.0034
60	0.2617	0.5284	2711	0.0007	0.0014	0.0021	0.0020	0.0023	0.0025	0.0029	0.0032	0.0042
61	0.2593	0.5268	2770	0.0003	0.0011	0.0017	0.0019	0.0022	0.0025	0.0029	0.0033	0.0035
62	0.2605	0.5281	2739	0.0004	0.0010	0.0018	0.0020	0.0023	0.0026	0.0029	0.0032	0.0034
63	0.2602	0.5267	2752	0.0004	0.0009	0.0015	0.0018	0.0024	0.0027	0.0031	0.0036	0.0038
64	0.2617	0.5264	2719	0.0005	0.0009	0.0015	0.0018	0.0022	0.0024	0.0028	0.0033	0.0035
65	0.2606	0.5267	2742	0.0003	0.0008	0.0014	0.0017	0.0020	0.0022	0.0025	0.0028	0.0036
66	0.2613	0.5267	2728	0.0003	0.0010	0.0013	0.0018	0.0021	0.0024	0.0028	0.0032	0.0044
67	0.2604	0.5268	2746	0.0005	0.0009	0.0013	0.0018	0.0020	0.0025	0.0028	0.0031	0.0034
68	0.2592	0.5278	2768	0.0003	0.0009	0.0015	0.0019	0.0021	0.0025	0.0032	0.0038	0.0026
69	0.2620	0.5279	2709	0.0004	0.0008	0.0016	0.0018	0.0022	0.0025	0.0030	0.0034	0.0041
70	0.2618	0.5266	2719	0.0005	0.0009	0.0017	0.0020	0.0025	0.0029	0.0033	0.0038	0.0046
71	0.2602	0.5271	2749	0.0005	0.0010	0.0018	0.0020	0.0026	0.0030	0.0034	0.0038	0.0039
72	0.2596	0.5271	2763	0.0006	0.0011	0.0019	0.0020	0.0025	0.0029	0.0031	0.0034	0.0036
73	0.2605	0.5267	2745	0.0005	0.0010	0.0019	0.0021	0.0023	0.0026	0.0027	0.0050	0.0045
74	0.2622	0.5281	2703	0.0006	0.0009	0.0014	0.0020	0.0025	0.0028	0.0033	0.0038	0.0046
75	0.2589	0.5247	2788	0.0005	0.0008	0.0016	0.0021	0.0024	0.0027	0.0030	0.0034	0.0024
Ave.	0.2605	0.5272	2742	0.0004	0.0010	0.0017	0.0020	0.0024	0.0027	0.0031	0.0036	0.0037
Med.	0.2604	0.5271	2742	0.0004	0.0010	0.0017	0.0020	0.0024	0.0027	0.0031	0.0035	0.0036
st dev	0.0014	0.0010	31.3901	0.0001	0.0002	0.0002	0.0001	0.0002	0.0002	0.0003	0.0004	0.0007
Min.	0.2566	0.5247	2682	0.0002	0.0008	0.0013	0.0017	0.0020	0.0022	0.0025	0.0028	0.0024
Max.	0.2633	0.5286	2840	0.0007	0.0014	0.0021	0.0024	0.0027	0.0031	0.0035	0.0050	0.0047



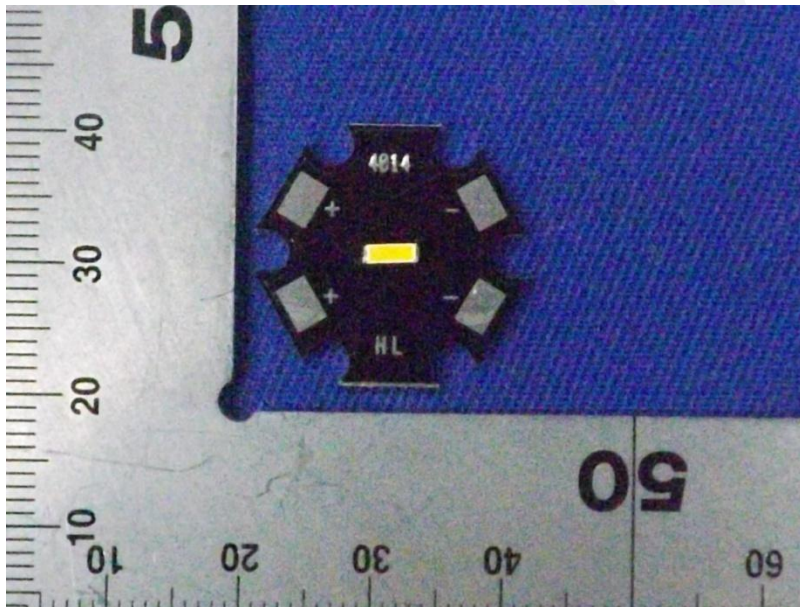
## Appendix A – EUT PHOTO

### A.1 Mechanical Dimensions (Ta = 25 °C)



All dimensions are in millimeter

### A.2 EUT Photo



\*\*\*\*\*END OF REPORT\*\*\*\*\*