



IESNA LM-80-2008

MEASURING LUMEN MAINTENANCE OF LED LIGHT SOURCES

MEASUREMENT AND TEST REPORT

For

Hongli Zhihui Group Co.,Ltd. Guangzhou Branch

Room 316, Building 2, No.1, Xianke Yi Road, Huadong Town, Huadu District, Guangzhou, China

Model: HL-A-3014HW-S1-08-HR3

| | |
|--|--|
| Report Type: 6000 Hours Test Report (See Section 1.9 Report Revision) | Product Type: LED Package |
| Test Engineer: | Daniel Duan <i>Daniel Duan</i> |
| Report Number: | RSZ120424501-10-M7 |
| Test Date: | 2012-04-26 to 2013-11-25 |
| Report Date: | 2019-01-12 |
| Revised Note: | The previous report RSZ120424501-10-M6 is replaced by this report on 2019-01-12 |
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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-3014HW-S1-08-HR3 |
| Part Type: | LED Package |
| Nominal CCT: | 2700K |
| Drive Current: | 30 mA |
| Power: | 0.102W |
| Average Current Density per LED die: | 197.82 mA/mm ² |
| Average Power Density per LED die: | 0.66 W/mm ² |
| CRI: | 80 |
| Die Spacing: | N/A |

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 No.69, Pulongcun, Puxinhu Industry Area, Tangxia, Dongguan, Guangdong, 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, length:0.3M ,0-1999LUMEN | 2013-03-08 | 2014-03-08 |
| Programmable Test Power for LEDs | EVERFINE | LED300E | 1008002 | 15V/2000mA | 2013-03-25 | 2014-03-25 |
| High accuracy array spectroradiometer | EVERFINE | HAAS-2000 | 1012016T | 380-780nm | 2013-03-08 | 2014-03-08 |
| Standard Light Source | EVERFINE | D062 | 1011064 | 2856K | 2013-05-23 | 2014-05-23 |
| Precision digital stabilized DC power supply | EVERFINE | WY605 | G115987CJ 7321114 | 300VA | 2013-03-25 | 2014-03-25 |
| LM-80 Aging equipment | BACL | N/A | #1 | N/A | 2013-03-25 | 2014-03-25 |
| Multi-channel DC source | Tai Shan Xing Guang | T01000F2 | ST04346 | 5V/1000mA | 2013-08-01 | 2014-08-01 |
| Digital CC&CV DC Power Supply | EVERFINE | WY5015 | 11090007 | (50V/15A) | 2013-03-25 | 2014-03-25 |

| Device | Manufacture | Model No | Serial No | Test Range | Calibration date | Calibration due date |
|--------------------------------|-------------|----------|-----------|------------|------------------|----------------------|
| Multilayer LM-80 aging machine | BACL | B2-270 | 20005 | 270pcs | 2013-08-01 | 2014-08-01 |

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 $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$, 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;

The 25pcs samples tested at T_s 85°C were received at 2012-02-24 and tested during 2012-04-26 to 2013-01-04. The samples were numbered from 1 to 25.

The other 50pcs samples tested at T_s 55°C and T_s 75°C were received at 2013-03-15 and tested during 2013-03-19 to 2013-11-25. The samples were numbered from 26 to 50 and 51 to 75.

Data Set 1: 55°C, 30mA (Tested during 2013-03-19 to 2013-11-25)

| | |
|--------------------------------------|----------------------------|
| Part Number: | HL-A-3014HW-S1-08-HR3 |
| Number of Units: | 25 |
| Actual Case Temperature(T_s): | $T_s = 54.3^\circ\text{C}$ |
| Actual Ambient Temperature(T_A): | $T_A = 53.6^\circ\text{C}$ |
| Life Test Drive Current: | $I_F = 30\text{mA}$ |
| Measurement Current: | $I_F = 30\text{mA}$ |

Data Set 2: 75°C, 30mA (Tested during 2013-03-19 to 2013-11-25)

| | |
|--------------------------------------|----------------------------|
| Part Number: | HL-A-3014HW-S1-08-HR3 |
| Number of Units: | 25 |
| Actual Case Temperature(T_s): | $T_s = 74.2^\circ\text{C}$ |
| Actual Ambient Temperature(T_A): | $T_A = 73.7^\circ\text{C}$ |
| Life Test Drive Current: | $I_F = 30\text{mA}$ |
| Measurement Current: | $I_F = 30\text{mA}$ |

Data Set 3: 85°C, 30mA (Tested during 2012-04-26 to 2013-01-04)

| | |
|--------------------------------------|----------------------------|
| Part Number: | HL-A-3014HW-S1-08-HR3 |
| Number of Units: | 25 |
| Actual Case Temperature(T_s): | $T_s = 84.6^\circ\text{C}$ |
| Actual Ambient Temperature(T_A): | $T_A = 81.1^\circ\text{C}$ |
| Life Test Drive Current: | $I_F = 30\text{mA}$ |
| Measurement Current: | $I_F = 30\text{mA}$ |

1.9 Report Revision

| Report Number | Report Date | Contents |
|--------------------|-------------|--|
| RSZ120424501-10 | 2013-01-21 | Original report. |
| RSZ120424501-10-M1 | 2013-04-03 | Update the product photo in page 8. |
| RSZ120424501-10-M2 | 2013-05-27 | A footnote is added in the first page. |
| RSZ120424501-10-M3 | 2014-01-07 | Add test results for samples at TS 55°C and TS 75°C and update rated CCT |
| RSZ120424501-10-M4 | 2014-01-14 | Update the format |
| RSZ120424501-10-M5 | 2015-03-04 | Update the logo of accredited body |
| RSZ120424501-10-M6 | 2015-09-15 | Correct the sample size and relevant test result |
| RSZ120424501-10-M7 | 2019-01-12 | Update the Logo and address of lab on the Page1&3 Update Company name and address on page 1. Add DUT Characteristics on page 3 according to ENERGY STAR requirements |

FINAL

2 - SUMMARY OF TEST RESULT

| Data Set: | Data Set 1, 55°C, 30mA |
|---|--|
| Number of Units: | 25 |
| Failures Observed: | 0 |
| Test Interval and Test Duration: | 0h,1000h,2000h,3000h,4000h,5000h,6000h (Tested during 2013-03-19 to 2013-11-25) |
| Average. Lumen Maintenance at 6000 hours: | 97.48% |
| Average Chromaticity Shift at 6000 hours ($\Delta u'v'$): | 0.0010 |
| Reported TM-21 L ₇₀ Lifetime: | >36,000 hours |

| Data Set: | Data Set 2, 75°C, 30mA |
|--|--|
| Number of Units: | 25 |
| Failures Observed: | 0 |
| Test Interval and Test Duration: | 0h,1000h,2000h,3000h,4000h,5000h,6000h (Tested during 2013-03-19 to 2013-11-25) |
| Average. Lumen Maintenance at 6000 hours: | 96.97% |
| Average Chromaticity Shift at 6000 hours($\Delta u'v'$): | 0.0011 |
| Reported TM-21 L ₇₀ Lifetime | >36,000 hours |

| Data Set: | Data Set 3, 85°C, 30mA |
|--|--|
| Number of Units: | 25 |
| Failures Observed: | 0 |
| Test Interval and Test Duration: | 0h,1000h,2000h,3000h,4000h,5000h,6000h (Tested during 2012-04-26 to 2013-01-04) |
| Average. Lumen Maintenance at 6000 hours: | 95.30% |
| Average Chromaticity Shift at 6000 hours($\Delta u'v'$): | 0.0011 |
| Reported TM-21 L ₇₀ Lifetime | >36,000 hours |

3 - Test Data

3.1 Data Set 1, 55°C, 30mA (Lumen Maintenance)

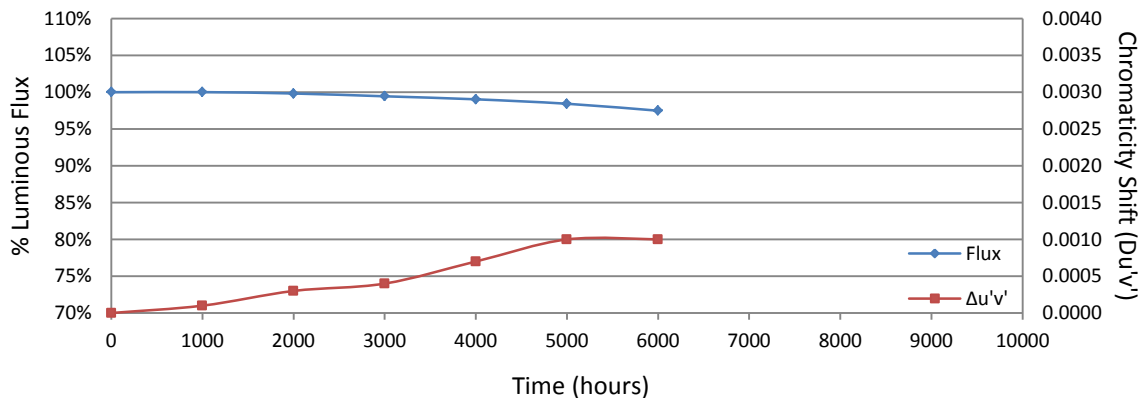
| No. | V _F (V) | Φ(lm) | Lumen Maintenance (%) | | | | | |
|--------|--------------------|-------|-----------------------|---------|---------|---------|---------|---------|
| | 0hr(Initial) | | 1000hrs | 2000hrs | 3000hrs | 4000hrs | 5000hrs | 6000hrs |
| 26 | 2.932 | 7.761 | 99.97 | 99.59 | 99.12 | 98.84 | 98.08 | 97.33 |
| 27 | 2.945 | 7.770 | 99.92 | 99.63 | 99.29 | 98.98 | 98.55 | 97.63 |
| 28 | 2.929 | 7.773 | 99.77 | 99.91 | 99.25 | 99.07 | 98.52 | 97.32 |
| 29 | 2.921 | 7.754 | 99.97 | 99.99 | 99.19 | 99.10 | 98.58 | 97.49 |
| 30 | 2.932 | 7.830 | 100.14 | 100.08 | 99.34 | 99.18 | 98.58 | 97.31 |
| 31 | 2.929 | 7.811 | 100.19 | 100.20 | 99.44 | 99.53 | 98.45 | 97.90 |
| 32 | 2.943 | 7.788 | 99.82 | 99.77 | 98.91 | 98.81 | 97.75 | 97.25 |
| 33 | 2.929 | 7.792 | 100.04 | 99.83 | 99.50 | 99.28 | 98.65 | 97.68 |
| 34 | 2.938 | 7.745 | 99.95 | 99.51 | 99.21 | 98.95 | 98.22 | 97.37 |
| 35 | 2.936 | 7.828 | 99.57 | 99.53 | 99.27 | 98.82 | 98.34 | 97.43 |
| 36 | 2.931 | 7.794 | 99.96 | 99.79 | 99.45 | 98.78 | 98.19 | 97.11 |
| 37 | 2.939 | 7.770 | 100.13 | 99.72 | 99.58 | 97.46 | 98.24 | 97.58 |
| 38 | 2.917 | 7.789 | 100.59 | 100.27 | 99.82 | 99.42 | 98.75 | 97.73 |
| 39 | 2.932 | 7.802 | 100.47 | 99.88 | 99.53 | 99.30 | 98.21 | 97.67 |
| 40 | 2.933 | 7.799 | 100.28 | 100.01 | 99.59 | 99.42 | 98.78 | 97.78 |
| 41 | 2.933 | 7.791 | 100.10 | 99.83 | 99.36 | 99.23 | 98.33 | 97.30 |
| 42 | 2.918 | 7.751 | 100.04 | 99.78 | 99.59 | 98.83 | 98.13 | 97.28 |
| 43 | 2.926 | 7.762 | 100.03 | 100.06 | 99.69 | 99.25 | 98.76 | 97.81 |
| 44 | 2.940 | 7.762 | 100.04 | 99.79 | 99.70 | 99.21 | 98.94 | 97.80 |
| 45 | 2.958 | 7.858 | 99.48 | 99.59 | 99.57 | 99.17 | 98.23 | 97.51 |
| 46 | 2.922 | 7.797 | 99.74 | 99.62 | 99.40 | 98.55 | 98.47 | 97.09 |
| 47 | 2.935 | 7.817 | 99.74 | 99.37 | 99.12 | 98.76 | 98.04 | 97.07 |
| 48 | 2.930 | 7.823 | 100.12 | 99.77 | 99.69 | 99.19 | 98.58 | 96.82 |
| 49 | 2.921 | 7.847 | 100.19 | 99.99 | 99.85 | 99.38 | 98.65 | 97.85 |
| 50 | 2.926 | 7.779 | 99.99 | 99.90 | 99.64 | 99.29 | 98.71 | 97.81 |
| Ave. | 2.932 | 7.792 | 100.01 | 99.82 | 99.44 | 99.03 | 98.43 | 97.48 |
| Med. | 2.932 | 7.791 | 100.03 | 99.79 | 99.45 | 99.17 | 98.47 | 97.49 |
| st dev | 0.0091 | 0.030 | 0.0025 | 0.0022 | 0.0024 | 0.0041 | 0.0028 | 0.0029 |
| Min. | 2.917 | 7.745 | 99.48 | 99.37 | 98.91 | 97.46 | 97.75 | 96.82 |
| Max. | 2.958 | 7.858 | 100.59 | 100.27 | 99.85 | 99.53 | 98.94 | 97.90 |

TM-21 Projection:

Test Duration: 6000 hours
Failures Observed: 0
 α : 4.980E-06
 β : 1.008
Calculated L₇₀: 73,000
Reported L₇₀: >36,000

3.2 Data Set 1, 55°C, 30mA (Chromaticity Shift)

| No. | u' | v' | CCT(K) | Chromaticity Shift ($\Delta u'v'$) | | | | | |
|--------|--------------|---------|----------|--------------------------------------|---------|---------|---------|---------|---------|
| | Ohr(Initial) | | | 1000hrs | 2000hrs | 3000hrs | 4000hrs | 5000hrs | 6000hrs |
| 26 | 0.2586 | 0.5305 | 2769 | 0.0000 | 0.0003 | 0.0004 | 0.0006 | 0.0009 | 0.0008 |
| 27 | 0.2572 | 0.5311 | 2795 | 0.0001 | 0.0003 | 0.0004 | 0.0007 | 0.0010 | 0.0011 |
| 28 | 0.2580 | 0.5314 | 2778 | 0.0002 | 0.0003 | 0.0005 | 0.0008 | 0.0011 | 0.0009 |
| 29 | 0.2620 | 0.5350 | 2680 | 0.0001 | 0.0002 | 0.0004 | 0.0007 | 0.0009 | 0.0010 |
| 30 | 0.2602 | 0.5322 | 2729 | 0.0001 | 0.0003 | 0.0004 | 0.0008 | 0.0010 | 0.0007 |
| 31 | 0.2593 | 0.5305 | 2753 | 0.0000 | 0.0002 | 0.0004 | 0.0007 | 0.0010 | 0.0010 |
| 32 | 0.2586 | 0.5309 | 2768 | 0.0002 | 0.0003 | 0.0004 | 0.0009 | 0.0011 | 0.0012 |
| 33 | 0.2591 | 0.5301 | 2759 | 0.0000 | 0.0002 | 0.0004 | 0.0007 | 0.0010 | 0.0011 |
| 34 | 0.2602 | 0.5304 | 2736 | 0.0001 | 0.0003 | 0.0004 | 0.0009 | 0.0012 | 0.0012 |
| 35 | 0.2585 | 0.5309 | 2768 | 0.0001 | 0.0003 | 0.0003 | 0.0006 | 0.0009 | 0.0010 |
| 36 | 0.2587 | 0.5306 | 2766 | 0.0001 | 0.0003 | 0.0003 | 0.0003 | 0.0006 | 0.0004 |
| 37 | 0.2600 | 0.5311 | 2737 | 0.0001 | 0.0003 | 0.0004 | 0.0005 | 0.0011 | 0.0012 |
| 38 | 0.2584 | 0.5303 | 2773 | 0.0000 | 0.0002 | 0.0003 | 0.0006 | 0.0010 | 0.0011 |
| 39 | 0.2588 | 0.5289 | 2771 | 0.0002 | 0.0002 | 0.0003 | 0.0008 | 0.0011 | 0.0012 |
| 40 | 0.2600 | 0.5301 | 2740 | 0.0001 | 0.0003 | 0.0004 | 0.0008 | 0.0011 | 0.0012 |
| 41 | 0.2580 | 0.5301 | 2784 | 0.0001 | 0.0002 | 0.0003 | 0.0006 | 0.0007 | 0.0008 |
| 42 | 0.2568 | 0.5306 | 2806 | 0.0000 | 0.0003 | 0.0003 | 0.0003 | 0.0003 | 0.0003 |
| 43 | 0.2601 | 0.5310 | 2734 | 0.0001 | 0.0002 | 0.0003 | 0.0008 | 0.0010 | 0.0011 |
| 44 | 0.2592 | 0.5296 | 2760 | 0.0001 | 0.0002 | 0.0003 | 0.0007 | 0.0010 | 0.0011 |
| 45 | 0.2605 | 0.5317 | 2723 | 0.0002 | 0.0003 | 0.0003 | 0.0007 | 0.0011 | 0.0011 |
| 46 | 0.2576 | 0.5298 | 2793 | 0.0001 | 0.0003 | 0.0003 | 0.0007 | 0.0010 | 0.0007 |
| 47 | 0.2588 | 0.5300 | 2767 | 0.0000 | 0.0002 | 0.0004 | 0.0007 | 0.0009 | 0.0009 |
| 48 | 0.2599 | 0.5303 | 2743 | 0.0001 | 0.0003 | 0.0004 | 0.0009 | 0.0012 | 0.0007 |
| 49 | 0.2595 | 0.5303 | 2750 | 0.0001 | 0.0002 | 0.0003 | 0.0008 | 0.0011 | 0.0011 |
| 50 | 0.2592 | 0.5313 | 2752 | 0.0000 | 0.0001 | 0.0002 | 0.0006 | 0.0009 | 0.0010 |
| Ave. | 0.2591 | 0.5307 | 2757 | 0.0001 | 0.0003 | 0.0004 | 0.0007 | 0.0010 | 0.0010 |
| Med. | 0.2591 | 0.5305 | 2760 | 0.0001 | 0.0003 | 0.0004 | 0.0007 | 0.0010 | 0.0010 |
| st dev | 0.00115 | 0.00113 | 26.73462 | 0.00007 | 0.00005 | 0.00006 | 0.00015 | 0.00020 | 0.00024 |
| Min. | 0.2568 | 0.5289 | 2680 | 0.0000 | 0.0001 | 0.0002 | 0.0003 | 0.0003 | 0.0003 |
| Max. | 0.2620 | 0.5350 | 2806 | 0.0002 | 0.0003 | 0.0005 | 0.0009 | 0.0012 | 0.0012 |



3.3 Data Set 2, 75°C, 30mA (Lumen Maintenance)

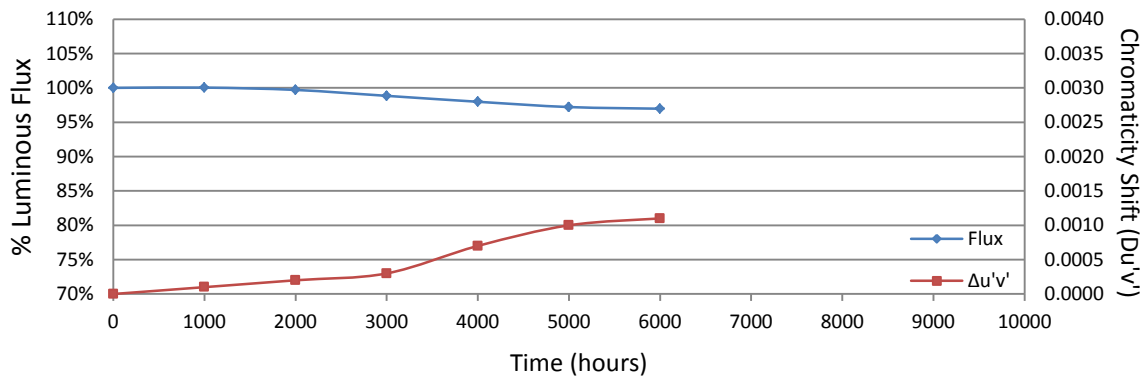
| No. | V _F (V) | Φ(lm) | Lumen Maintenance (%) | | | | | |
|--------|--------------------|-------|-----------------------|---------|---------|---------|---------|---------|
| | Ohr(Initial) | | 1000hrs | 2000hrs | 3000hrs | 4000hrs | 5000hrs | 6000hrs |
| 51 | 2.909 | 7.780 | 100.01 | 99.78 | 98.89 | 98.07 | 97.51 | 96.81 |
| 52 | 2.896 | 7.769 | 99.90 | 99.52 | 98.65 | 98.13 | 97.48 | 97.14 |
| 53 | 2.924 | 7.822 | 99.87 | 99.48 | 98.67 | 97.86 | 97.16 | 96.88 |
| 54 | 2.912 | 7.770 | 99.86 | 99.33 | 98.69 | 97.88 | 97.21 | 96.82 |
| 55 | 2.912 | 7.758 | 100.08 | 99.59 | 98.94 | 97.82 | 97.43 | 96.97 |
| 56 | 2.928 | 7.793 | 100.32 | 99.91 | 98.72 | 97.96 | 97.27 | 97.05 |
| 57 | 2.905 | 7.765 | 100.10 | 99.65 | 98.91 | 98.24 | 97.48 | 97.15 |
| 58 | 2.931 | 7.846 | 99.85 | 99.50 | 98.64 | 97.82 | 97.11 | 96.88 |
| 59 | 2.916 | 7.865 | 100.06 | 99.68 | 98.66 | 97.72 | 97.04 | 96.66 |
| 60 | 2.926 | 7.660 | 99.84 | 99.71 | 98.69 | 97.86 | 96.45 | 96.74 |
| 61 | 2.898 | 7.814 | 100.12 | 99.92 | 98.68 | 98.21 | 97.35 | 97.18 |
| 62 | 2.920 | 7.858 | 100.09 | 99.81 | 98.89 | 98.07 | 97.25 | 97.07 |
| 63 | 2.915 | 7.865 | 100.09 | 99.68 | 98.98 | 97.98 | 97.37 | 97.09 |
| 64 | 2.905 | 7.778 | 99.96 | 99.82 | 98.84 | 98.14 | 97.11 | 97.21 |
| 65 | 2.936 | 7.823 | 100.45 | 99.49 | 99.28 | 98.31 | 97.52 | 96.75 |
| 66 | 2.921 | 7.817 | 100.32 | 99.99 | 99.16 | 98.34 | 97.58 | 97.26 |
| 67 | 2.936 | 7.804 | 99.94 | 99.58 | 98.53 | 97.62 | 96.82 | 96.58 |
| 68 | 2.908 | 7.796 | 99.92 | 99.68 | 98.83 | 97.96 | 96.95 | 96.97 |
| 69 | 2.914 | 7.822 | 100.08 | 99.68 | 98.79 | 97.81 | 96.96 | 96.87 |
| 70 | 2.931 | 7.795 | 100.17 | 99.91 | 98.82 | 98.00 | 97.23 | 97.22 |
| 71 | 2.912 | 7.698 | 99.88 | 99.71 | 98.77 | 98.00 | 97.25 | 97.10 |
| 72 | 2.927 | 7.827 | 100.03 | 99.72 | 99.04 | 97.96 | 97.18 | 97.10 |
| 73 | 2.919 | 7.741 | 99.94 | 99.66 | 98.54 | 97.56 | 96.73 | 96.24 |
| 74 | 2.920 | 7.813 | 100.19 | 99.99 | 99.32 | 98.31 | 97.64 | 97.45 |
| 75 | 2.926 | 7.836 | 99.89 | 99.74 | 98.95 | 97.93 | 97.19 | 97.17 |
| Ave. | 2.918 | 7.797 | 100.04 | 99.70 | 98.84 | 97.98 | 97.21 | 96.97 |
| Med. | 2.919 | 7.804 | 100.03 | 99.68 | 98.82 | 97.96 | 97.23 | 97.05 |
| st dev | 0.0110 | 0.049 | 0.0016 | 0.0017 | 0.0021 | 0.0021 | 0.0028 | 0.0026 |
| Min. | 2.896 | 7.660 | 99.84 | 99.33 | 98.53 | 97.56 | 96.45 | 96.24 |
| Max. | 2.936 | 7.865 | 100.45 | 99.99 | 99.32 | 98.34 | 97.64 | 97.45 |

TM-21 Projection:

Test Duration: 6000 hours
Failures Observed: 0
 α : 6.870E-06
 β : 1.008
Calculated L₇₀: 53,000 hours
Reported L₇₀: >36000 hours

3.4 Data Set 2, 75°C, 30mA (Chromaticity Shift)

| No. | u' | v' | CCT(K) | Chromaticity Shift ($\Delta u'v'$) | | | | | |
|--------|--------------|---------|---------|--------------------------------------|---------|---------|---------|---------|---------|
| | 0hr(Initial) | | | 1000hrs | 2000hrs | 3000hrs | 4000hrs | 5000hrs | 6000hrs |
| 51 | 0.2594 | 0.5289 | 2762 | 0.0002 | 0.0003 | 0.0004 | 0.0008 | 0.0011 | 0.0012 |
| 52 | 0.2595 | 0.5290 | 2755 | 0.0000 | 0.0002 | 0.0002 | 0.0006 | 0.0009 | 0.0011 |
| 53 | 0.2596 | 0.5308 | 2744 | 0.0000 | 0.0002 | 0.0003 | 0.0006 | 0.0009 | 0.0010 |
| 54 | 0.2572 | 0.5313 | 2793 | 0.0001 | 0.0002 | 0.0002 | 0.0007 | 0.0009 | 0.0010 |
| 55 | 0.2577 | 0.5303 | 2788 | 0.0001 | 0.0002 | 0.0002 | 0.0007 | 0.0010 | 0.0011 |
| 56 | 0.2592 | 0.5297 | 2761 | 0.0002 | 0.0002 | 0.0005 | 0.0009 | 0.0012 | 0.0013 |
| 57 | 0.2598 | 0.5301 | 2745 | 0.0001 | 0.0002 | 0.0002 | 0.0006 | 0.0009 | 0.0011 |
| 58 | 0.2595 | 0.5299 | 2753 | 0.0001 | 0.0001 | 0.0002 | 0.0007 | 0.0010 | 0.0010 |
| 59 | 0.2590 | 0.5316 | 2756 | 0.0001 | 0.0002 | 0.0003 | 0.0007 | 0.0010 | 0.0011 |
| 60 | 0.2589 | 0.5281 | 2772 | 0.0000 | 0.0001 | 0.0003 | 0.0006 | 0.0009 | 0.0010 |
| 61 | 0.2586 | 0.5284 | 2778 | 0.0000 | 0.0002 | 0.0004 | 0.0007 | 0.0009 | 0.0010 |
| 62 | 0.2600 | 0.5312 | 2736 | 0.0001 | 0.0002 | 0.0002 | 0.0006 | 0.0009 | 0.0010 |
| 63 | 0.2582 | 0.5313 | 2774 | 0.0001 | 0.0002 | 0.0002 | 0.0007 | 0.0009 | 0.0010 |
| 64 | 0.2594 | 0.5290 | 2758 | 0.0001 | 0.0001 | 0.0002 | 0.0007 | 0.0009 | 0.0010 |
| 65 | 0.2583 | 0.5312 | 2769 | 0.0001 | 0.0001 | 0.0001 | 0.0006 | 0.0009 | 0.0010 |
| 66 | 0.2601 | 0.5301 | 2740 | 0.0001 | 0.0002 | 0.0002 | 0.0007 | 0.0010 | 0.0011 |
| 67 | 0.2580 | 0.5311 | 2779 | 0.0001 | 0.0002 | 0.0003 | 0.0008 | 0.0010 | 0.0012 |
| 68 | 0.2598 | 0.5301 | 2743 | 0.0001 | 0.0002 | 0.0003 | 0.0006 | 0.0009 | 0.0010 |
| 69 | 0.2580 | 0.5317 | 2776 | 0.0001 | 0.0001 | 0.0002 | 0.0006 | 0.0008 | 0.0010 |
| 70 | 0.2603 | 0.5307 | 2733 | 0.0001 | 0.0002 | 0.0003 | 0.0007 | 0.0009 | 0.0011 |
| 71 | 0.2606 | 0.5301 | 2729 | 0.0000 | 0.0001 | 0.0002 | 0.0007 | 0.0009 | 0.0010 |
| 72 | 0.2592 | 0.5303 | 2756 | 0.0001 | 0.0002 | 0.0003 | 0.0007 | 0.0010 | 0.0010 |
| 73 | 0.2573 | 0.5293 | 2801 | 0.0001 | 0.0001 | 0.0003 | 0.0006 | 0.0009 | 0.0012 |
| 74 | 0.2604 | 0.5309 | 2732 | 0.0001 | 0.0002 | 0.0002 | 0.0007 | 0.0011 | 0.0011 |
| 75 | 0.2611 | 0.5309 | 2716 | 0.0001 | 0.0002 | 0.0003 | 0.0008 | 0.0010 | 0.0011 |
| Ave. | 0.2592 | 0.5302 | 2758 | 0.0001 | 0.0002 | 0.0003 | 0.0007 | 0.0010 | 0.0011 |
| Med. | 0.2594 | 0.5303 | 2756 | 0.0001 | 0.0002 | 0.0002 | 0.0007 | 0.0009 | 0.0010 |
| st dev | 0.00104 | 0.00101 | 21.4893 | 0.00006 | 0.00005 | 0.00008 | 0.00008 | 0.00009 | 0.00008 |
| Min. | 0.2572 | 0.5281 | 2716 | 0.0000 | 0.0001 | 0.0001 | 0.0006 | 0.0008 | 0.0010 |
| Max. | 0.2611 | 0.5317 | 2801 | 0.0002 | 0.0003 | 0.0005 | 0.0009 | 0.0012 | 0.0013 |



3.5 Data Set 3, 85°C, 30mA (Lumen Maintenance)

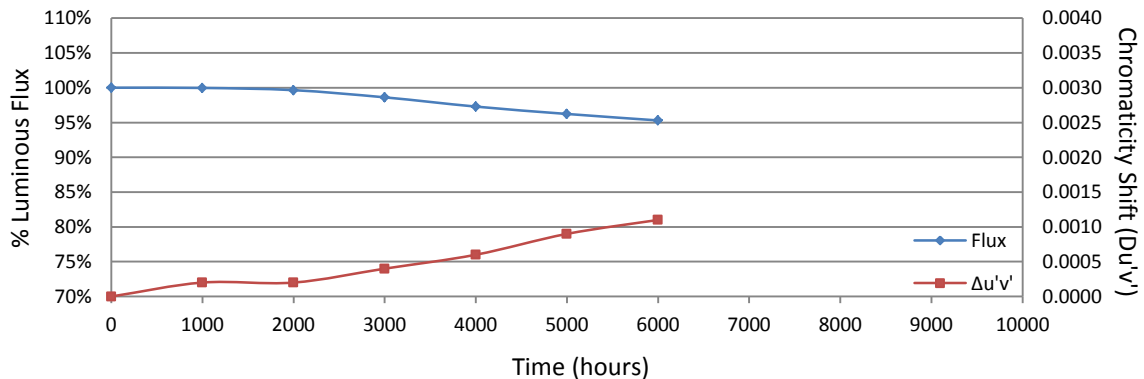
| No. | V _F (V) | Φ(lm) | Lumen Maintenance (%) | | | | | |
|--------|--------------------|--------|-----------------------|---------|---------|---------|---------|---------|
| | Ohr(Initial) | | 1000hrs | 2000hrs | 3000hrs | 4000hrs | 5000hrs | 6000hrs |
| 1 | 3.096 | 7.635 | 100.07 | 99.74 | 98.81 | 97.51 | 96.31 | 95.49 |
| 2 | 3.093 | 6.868 | 99.87 | 99.64 | 98.59 | 97.16 | 96.03 | 95.08 |
| 4 | 3.086 | 7.742 | 99.92 | 99.63 | 98.61 | 97.27 | 96.14 | 95.18 |
| 5 | 3.086 | 7.707 | 99.84 | 99.55 | 98.59 | 97.11 | 96.09 | 95.19 |
| 6 | 3.092 | 7.206 | 99.92 | 99.71 | 98.64 | 97.27 | 96.18 | 95.43 |
| 7 | 3.084 | 7.729 | 100.22 | 99.79 | 98.55 | 97.19 | 96.13 | 95.12 |
| 8 | 3.107 | 7.823 | 99.83 | 99.59 | 98.63 | 97.28 | 96.33 | 95.50 |
| 9 | 3.086 | 8.041 | 99.88 | 99.58 | 98.51 | 97.33 | 96.22 | 95.19 |
| 10 | 3.087 | 7.704 | 99.96 | 99.68 | 98.53 | 97.26 | 96.30 | 95.17 |
| 11 | 3.090 | 7.573 | 100.24 | 99.83 | 98.71 | 97.33 | 96.24 | 95.14 |
| 12 | 3.093 | 7.374 | 99.97 | 99.63 | 98.59 | 97.30 | 96.14 | 95.05 |
| 13 | 3.087 | 7.852 | 100.06 | 99.66 | 98.65 | 97.41 | 96.40 | 95.13 |
| 14 | 3.071 | 7.769 | 100.00 | 99.76 | 98.65 | 97.34 | 96.11 | 96.27 |
| 15 | 3.074 | 7.585 | 99.82 | 99.55 | 98.76 | 97.30 | 96.12 | 95.28 |
| 16 | 3.082 | 7.550 | 99.96 | 99.59 | 98.61 | 97.35 | 96.15 | 95.47 |
| 17 | 3.082 | 7.697 | 99.91 | 99.60 | 98.51 | 97.18 | 96.17 | 95.08 |
| 18 | 3.083 | 7.477 | 99.99 | 99.68 | 98.70 | 97.39 | 96.19 | 95.27 |
| 19 | 3.090 | 7.747 | 99.82 | 99.56 | 98.54 | 97.11 | 96.28 | 95.35 |
| 20 | 3.096 | 7.786 | 99.88 | 99.54 | 98.52 | 97.11 | 96.21 | 95.21 |
| 21 | 3.106 | 7.643 | 99.95 | 99.56 | 98.73 | 97.45 | 96.36 | 95.20 |
| 22 | 3.098 | 7.687 | 99.96 | 99.66 | 98.74 | 97.42 | 96.36 | 95.38 |
| 23 | 3.101 | 7.931 | 100.26 | 99.76 | 98.64 | 97.35 | 96.49 | 95.51 |
| 24 | 3.097 | 7.313 | 99.93 | 99.69 | 98.50 | 97.18 | 96.32 | 95.36 |
| 25 | 3.076 | 7.858 | 100.06 | 99.72 | 98.68 | 97.34 | 96.21 | 95.09 |
| Ave. | 3.089 | 7.637 | 99.97 | 99.65 | 98.62 | 97.29 | 96.23 | 95.30 |
| Med. | 3.089 | 7.701 | 99.95 | 99.65 | 98.62 | 97.30 | 96.21 | 95.20 |
| st dev | 0.0092 | 0.2517 | 0.1264 | 0.0836 | 0.0869 | 0.1111 | 0.1127 | 0.2542 |
| Min. | 3.071 | 6.868 | 99.82 | 99.54 | 98.50 | 97.11 | 96.03 | 95.05 |
| Max. | 3.107 | 8.041 | 100.26 | 99.83 | 98.81 | 97.51 | 96.49 | 96.27 |

TM-21 Projection:

Test Duration: 6000 hours
Failures Observed: 0
 α : 1.022E-05
 β : 1.014
Calculated L₇₀: 36,000 hours
Reported L₇₀: >36,000 hours

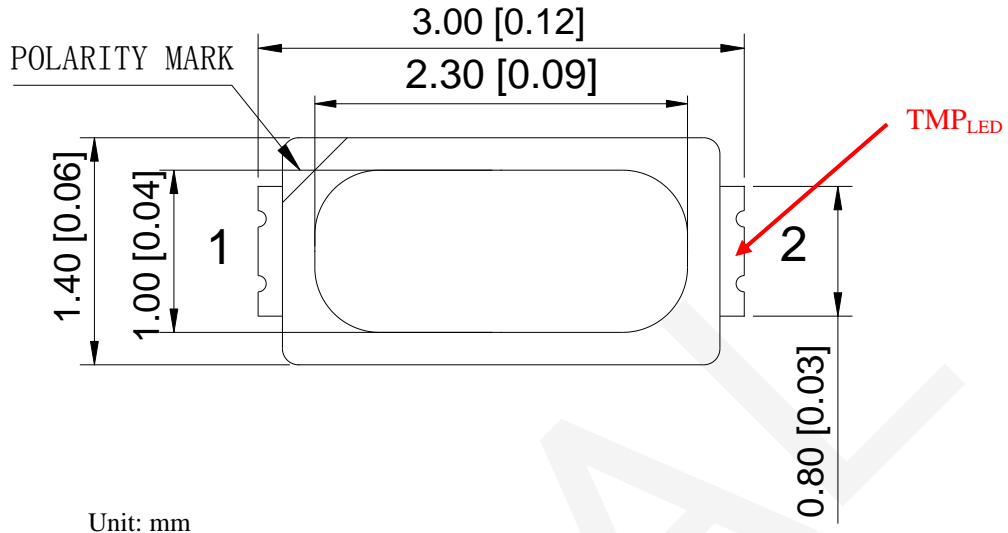
3.6 Data Set 3, 85°C, 30mA (Chromaticity Shift)

| No. | u' | v' | CCT(K) | Chromaticity Shift ($\Delta u'v'$) | | | | | |
|--------|--------------|--------|---------|--------------------------------------|---------|---------|---------|---------|---------|
| | Ohr(Initial) | | | 1000hrs | 2000hrs | 3000hrs | 4000hrs | 5000hrs | 6000hrs |
| 1 | 0.2589 | 0.5276 | 2775 | 0.0003 | 0.0004 | 0.0007 | 0.0011 | 0.0011 | 0.0013 |
| 2 | 0.2548 | 0.5255 | 2875 | 0.0003 | 0.0004 | 0.0003 | 0.0008 | 0.0011 | 0.0013 |
| 3 | 0.2552 | 0.5270 | 2858 | 0.0000 | 0.0004 | 0.0007 | 0.0003 | 0.0005 | 0.0008 |
| 4 | 0.2580 | 0.5287 | 2788 | 0.0001 | 0.0001 | 0.0003 | 0.0007 | 0.0012 | 0.0012 |
| 5 | 0.2588 | 0.5282 | 2775 | 0.0002 | 0.0004 | 0.0008 | 0.0005 | 0.0010 | 0.0011 |
| 6 | 0.2568 | 0.5287 | 2815 | 0.0002 | 0.0002 | 0.0006 | 0.0006 | 0.0009 | 0.0010 |
| 7 | 0.2569 | 0.5293 | 2810 | 0.0002 | 0.0004 | 0.0007 | 0.0004 | 0.0009 | 0.0009 |
| 8 | 0.2552 | 0.5300 | 2844 | 0.0003 | 0.0002 | 0.0007 | 0.0005 | 0.0007 | 0.0007 |
| 9 | 0.2582 | 0.5296 | 2781 | 0.0002 | 0.0001 | 0.0007 | 0.0007 | 0.0010 | 0.0011 |
| 10 | 0.2570 | 0.5296 | 2806 | 0.0002 | 0.0001 | 0.0003 | 0.0007 | 0.0011 | 0.0014 |
| 11 | 0.2593 | 0.5273 | 2768 | 0.0003 | 0.0001 | 0.0005 | 0.0011 | 0.0011 | 0.0014 |
| 12 | 0.2586 | 0.5278 | 2781 | 0.0002 | 0.0003 | 0.0002 | 0.0008 | 0.0008 | 0.0009 |
| 13 | 0.2572 | 0.5265 | 2816 | 0.0004 | 0.0001 | 0.0001 | 0.0004 | 0.0007 | 0.0009 |
| 14 | 0.2579 | 0.5299 | 2786 | 0.0002 | 0.0002 | 0.0006 | 0.0007 | 0.0007 | 0.0011 |
| 15 | 0.2576 | 0.5289 | 2798 | 0.0002 | 0.0002 | 0.0004 | 0.0009 | 0.0011 | 0.0012 |
| 16 | 0.2591 | 0.5290 | 2765 | 0.0002 | 0.0004 | 0.0004 | 0.0003 | 0.0008 | 0.0009 |
| 17 | 0.2578 | 0.5252 | 2809 | 0.0001 | 0.0001 | 0.0005 | 0.0005 | 0.0006 | 0.0009 |
| 18 | 0.2556 | 0.5268 | 2852 | 0.0002 | 0.0001 | 0.0003 | 0.0005 | 0.0009 | 0.0012 |
| 19 | 0.2583 | 0.5296 | 2779 | 0.0002 | 0.0001 | 0.0002 | 0.0005 | 0.0008 | 0.0012 |
| 20 | 0.2574 | 0.5286 | 2802 | 0.0002 | 0.0004 | 0.0003 | 0.0008 | 0.0009 | 0.0009 |
| 21 | 0.2602 | 0.5300 | 2737 | 0.0001 | 0.0002 | 0.0001 | 0.0006 | 0.0008 | 0.0009 |
| 22 | 0.2595 | 0.5306 | 2749 | 0.0004 | 0.0001 | 0.0004 | 0.0003 | 0.0009 | 0.0011 |
| 23 | 0.2581 | 0.5302 | 2781 | 0.0003 | 0.0001 | 0.0001 | 0.0008 | 0.0008 | 0.0010 |
| 24 | 0.2575 | 0.5290 | 2798 | 0.0001 | 0.0002 | 0.0000 | 0.0011 | 0.0012 | 0.0012 |
| 25 | 0.2593 | 0.5291 | 2760 | 0.0004 | 0.0004 | 0.0006 | 0.0002 | 0.0008 | 0.0010 |
| Ave. | 0.2577 | 0.5285 | 2796 | 0.0002 | 0.0002 | 0.0004 | 0.0006 | 0.0009 | 0.0011 |
| Med. | 0.2579 | 0.5289 | 2788 | 0.0002 | 0.0002 | 0.0004 | 0.0006 | 0.0009 | 0.0011 |
| st dev | 0.0014 | 0.0015 | 33.8707 | 0.0001 | 0.0001 | 0.0002 | 0.0003 | 0.0002 | 0.0002 |
| Min. | 0.2548 | 0.5252 | 2737 | 0.0000 | 0.0001 | 0.0000 | 0.0002 | 0.0005 | 0.0007 |
| Max. | 0.2602 | 0.5306 | 2875 | 0.0004 | 0.0004 | 0.0008 | 0.0011 | 0.0012 | 0.0014 |



Appendix A – EUT PHOTO

A.1 Mechanical Dimensions (Ta = 25°C)



A.2 EUT Photo



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