

IESNA LM-80-2008

MEASURING LUMEN MAINTENANCE OF LED LIGHT SOURCES

MEASUREMENT AND TEST REPORT For

SHENZHEN MTC LIGHTING CO., LTD.

NO.65, Chuangyi Road, Dalang Street, Baoan District, Shenzhen, Guangdong Province, CHINA

Model: MTLB-2835WB

| | | | |
|---|--|-------------------------------------|--|
| Report Type: 6000 Hours Test Report | | Product Type: LED Package | |
| Test Engineer: | Daniel Duan | <i>Daniel Duan</i> | |
| Report Number: | RSZ130823507-10 | | |
| Test Date: | 2013-09-16 to 2014-04-28 | | |
| Report Date: | 2014-05-08 | | |
| Reviewed By: | Jeanne Han /Safety Manager | <i>Jeanne Han</i> | |
| Prepared By: | Bay Area Compliance Laboratories Corp. (Dongguan). Pu Long Cun 69, Puxinghu Industrial Area, Tangxia Town, Dongguan, Guangdong, P.R.China. Tel: +86-0769-86858888 Fax: +86-0769-86858588 | | |

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).
 This report is valid only with a valid digital signature. The digital signature may be available only under the Adobe software above version 7.0.

TABLE OF CONTENTS

| | |
|---|-----------|
| 1 - GENERAL INFORMATION..... | 3 |
| 1.1 DESCRIPTION OF LED LIGHT SOURCES | 3 |
| 1.2 STANDARDS USED:..... | 3 |
| 1.3 TEST FACILITY | 3 |
| 1.4 DESCRIPTION OF AUXILIARY EQUIPMENT | 3 |
| 1.5 OPERATING CYCLE..... | 4 |
| 1.6 AMBIENT CONDITIONS | 4 |
| 1.7 PHOTOMETRY MEASUREMENT UNCERTAINTY | 4 |
| 1.8 SAMPLE SET | 5 |
| 2 - SUMMARY OF TEST RESULT | 6 |
| 3 - TEST DATA | 7 |
| 3.1 DATA SET 1, 55 °C, 120 mA (LUMEN MAINTENANCE)..... | 7 |
| 3.2 DATA SET 1, 55 °C, 120 mA (CHROMATICITY SHIFT) | 8 |
| 3.3 DATA SET 2, 85 °C, 120 mA (LUMEN MAINTENANCE)..... | 9 |
| 3.4 DATA SET 2, 85 °C, 120mA (CHROMATICITY SHIFT) | 10 |
| 3.5 DATA SET 3, 105 °C, 120 mA (LUMEN MAINTENANCE)..... | 11 |
| 3.6 DATA SET 3, 105 °C, 120 mA (CHROMATICITY SHIFT) | 12 |
| APPENDIX A – EUT PHOTO | 13 |
| A.1 MECHANICAL DIMENSIONS (TA = 25 °C) | 13 |
| A.2 EUT PHOTO | 13 |

1 - GENERAL INFORMATION

1.1 Description of LED Light Sources

Devices tested

Part Number: MTLB-2835WB
 Part Name: 2835
 Part Type: LED Package
 Nominal CCT: 3000K

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, length:0.3M ,0-1999LUMEN | 2014-03-04 | 2015-03-04 |
| Programmable Test Power for LEDs | EVERFINE | LED300E | 1008002 | 15V/2000mA | 2014-03-12 | 2015-03-12 |
| High accuracy array spectroradiometer | EVERFINE | HAAS-2000 | 1012016T | 380-780nm | 2013-12-26 | 2014-12-26 |
| Standard Light Source | EVERFINE | D062 | 1011093 | N/A | 2013-05-23 | 2014-05-23 |
| Precision digital stabilized DC power supply | EVERFINE | WY605 | G115987CJ 7321114 | 300VA | 2014-03-12 | 2015-03-12 |
| Multilayen aging machine | Bacl | B2-270 | 20005 | N/A | 2013-08-01 | 2014-08-01 |
| Multi-channel DC source | Taishan Xingguang | T01000F2 | ST04386 | 0~5V,0~40A | 2013-08-01 | 2014-08-01 |
| Multi-channel DC source | Taishan Xingguang | T01000F2 | ST04392 | 0~5V,0~40A | 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 $25\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$, 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 2013-09-14 and tested during 2013-09-16 to 2014-04-28. The samples were numbered from 1 to 25, 26 to 50 and 51 to 75

Data Set 1: 55 °C, 120mA

| | |
|--|-------------------------|
| Part Number: | MTLB-2835WB |
| Number of Units: | 25 |
| Actual Case Temperature(T _S): | T _S =54.2 °C |
| Actual Ambient Temperature(T _A): | T _A =51.5 °C |
| Life Test Drive Current: | I _F = 120mA |
| Measurement Current: | I _F = 120mA |

Data Set 2: 85 °C,120mA

| | |
|--|-------------------------|
| Part Number: | MTLB-2835WB |
| Number of Units: | 25 |
| Actual Case Temperature(T _S): | T _S =84.1 °C |
| Actual Ambient Temperature(T _A): | T _A =82.5 °C |
| Life Test Drive Current: | I _F =120mA |
| Measurement Current: | I _F = 120mA |

Data Set 3: 105 °C, 120mA

| | |
|--|--------------------------|
| Part Number: | MTLB-2835WB |
| Number of Units: | 25 |
| Actual Case Temperature(T _S): | T _S =104.5 °C |
| Actual Ambient Temperature(T _A): | T _A =103.1 °C |
| Life Test Drive Current: | I _F = 120mA |
| Measurement Current: | I _F = 120mA |

2 - SUMMARY OF TEST RESULT

| Data Set: | Data Set 1, 55 °C, 120mA |
|---|--|
| Number of Units: | 25 |
| Failures Observed: | 0 |
| Test Interval and Test Duration: | 0h,1000h,2000h,3000h,4000h,5000h,6000h |
| Average. Lumen Maintenance at 6000 hours: | 97.14% |
| Average Chromaticity Shift at 6000 hours ($\Delta u'v'$): | 0.0019 |
| Reported TM-21 L ₇₀ Lifetime: | >36,000 hours |

| Data Set: | Data Set 2, 85 °C, 120mA |
|--|--|
| Number of Units: | 25 |
| Failures Observed: | 0 |
| Test Interval and Test Duration: | 0h,1000h,2000h,3000h,4000h,5000h,6000h |
| Average. Lumen Maintenance at 6000 hours: | 95.97% |
| Average Chromaticity Shift at 6000 hours($\Delta u'v'$): | 0.0020 |
| Reported TM-21 L ₇₀ Lifetime: | >36,000 hours |

| Data Set: | Data Set 3, 105 °C, 120mA |
|--|--|
| Number of Units: | 25 |
| Failures Observed: | 0 |
| Test Interval and Test Duration: | 0h,1000h,2000h,3000h,4000h,5000h,6000h |
| Average. Lumen Maintenance at 6000 hours: | 95.13% |
| Average Chromaticity Shift at 6000 hours($\Delta u'v'$): | 0.0027 |
| Reported TM-21 L ₇₀ Lifetime: | >36,000 hours |

3 - Test Data

3.1 Data Set 1, 55 °C, 120 mA (Lumen Maintenance)

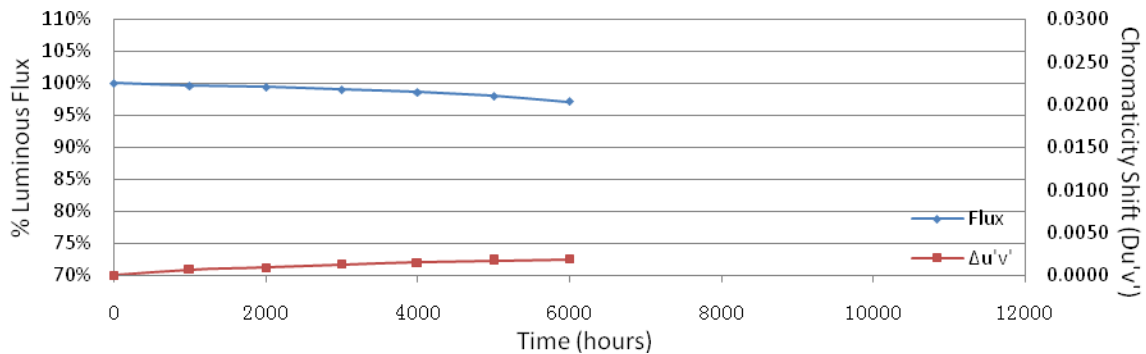
| No. | V _F (V) | Φ(lm) | Lumen Maintenance (%) | | | | | |
|--------|--------------------|--------|-----------------------|---------|---------|---------|---------|---------|
| | 0hr(Initial) | | 1000hrs | 2000hrs | 3000hrs | 4000hrs | 5000hrs | 6000hrs |
| 1 | 2.988 | 43.81 | 99.61 | 99.38 | 99.04 | 98.61 | 98.06 | 97.17 |
| 2 | 3.064 | 43.65 | 99.52 | 99.36 | 98.92 | 98.44 | 97.82 | 96.79 |
| 3 | 3.043 | 43.84 | 99.57 | 99.38 | 99.27 | 98.61 | 97.97 | 96.90 |
| 4 | 2.934 | 44.13 | 99.48 | 99.39 | 99.07 | 98.62 | 97.96 | 96.80 |
| 5 | 3.081 | 44.12 | 99.55 | 99.43 | 99.16 | 98.75 | 97.96 | 97.23 |
| 6 | 3.014 | 43.95 | 99.84 | 99.59 | 99.16 | 98.61 | 98.16 | 97.34 |
| 7 | 3.018 | 43.11 | 99.77 | 99.51 | 99.23 | 98.75 | 98.28 | 97.22 |
| 8 | 3.068 | 43.26 | 99.54 | 99.31 | 99.01 | 98.61 | 97.55 | 96.86 |
| 9 | 3.048 | 43.98 | 99.52 | 99.45 | 98.86 | 98.39 | 97.45 | 96.77 |
| 10 | 2.966 | 43.14 | 99.40 | 99.17 | 98.91 | 98.56 | 97.50 | 96.69 |
| 11 | 2.987 | 43.48 | 99.72 | 99.63 | 99.20 | 98.87 | 97.75 | 96.90 |
| 12 | 2.962 | 43.43 | 99.86 | 99.75 | 99.13 | 98.69 | 98.04 | 97.47 |
| 13 | 3.037 | 43.31 | 99.65 | 99.33 | 98.91 | 98.57 | 97.41 | 96.74 |
| 14 | 3.007 | 43.67 | 99.77 | 99.61 | 99.08 | 98.51 | 97.94 | 97.37 |
| 15 | 3.091 | 43.93 | 99.43 | 99.39 | 98.86 | 98.63 | 97.91 | 97.31 |
| 16 | 2.997 | 43.18 | 99.68 | 99.47 | 98.91 | 98.61 | 98.15 | 97.55 |
| 17 | 2.936 | 43.33 | 99.49 | 99.31 | 98.85 | 98.41 | 97.85 | 97.35 |
| 18 | 2.974 | 43.45 | 99.59 | 99.49 | 98.80 | 98.46 | 97.84 | 97.31 |
| 19 | 3.003 | 43.55 | 99.47 | 99.31 | 98.74 | 98.69 | 98.42 | 95.89 |
| 20 | 2.969 | 43.75 | 99.91 | 99.73 | 99.34 | 98.65 | 98.47 | 97.58 |
| 21 | 3.047 | 43.42 | 99.75 | 99.70 | 99.26 | 98.83 | 98.55 | 97.28 |
| 22 | 3.045 | 43.74 | 99.77 | 99.47 | 99.22 | 98.79 | 98.54 | 97.94 |
| 23 | 3.010 | 43.38 | 99.79 | 99.59 | 99.17 | 98.85 | 98.55 | 97.65 |
| 24 | 2.998 | 44.42 | 99.64 | 99.37 | 98.99 | 98.54 | 97.97 | 97.25 |
| 25 | 2.998 | 44.04 | 99.66 | 99.27 | 98.96 | 98.73 | 97.73 | 97.12 |
| Ave. | 3.011 | 43.643 | 99.64 | 99.46 | 99.04 | 98.63 | 97.99 | 97.14 |
| Med. | 3.007 | 43.650 | 99.64 | 99.43 | 99.04 | 98.61 | 97.96 | 97.23 |
| st dev | 0.0427 | 0.3505 | 0.1431 | 0.1511 | 0.1663 | 0.1328 | 0.3382 | 0.4133 |
| Min. | 2.934 | 43.110 | 99.40 | 99.17 | 98.74 | 98.39 | 97.41 | 95.89 |
| Max. | 3.091 | 44.420 | 99.91 | 99.75 | 99.34 | 98.87 | 98.55 | 97.94 |

TM-21 Projection:

Test Duration: 6000 hours
Failures Observed: 0
 α : 5.025E-06
 β : 1.004
Calculated L₇₀: 72,000hours
Reported L₇₀: >36,000hours

3.2 Data Set 1, 55 °C, 120 mA (Chromaticity Shift)

| No. | u' | v' | CCT(K) | Chromaticity Shift ($\Delta u'v'$) | | | | | |
|--------|--------------|--------|----------|--------------------------------------|---------|---------|---------|---------|---------|
| | 0hr(Initial) | | | 1000hrs | 2000hrs | 3000hrs | 4000hrs | 5000hrs | 6000hrs |
| 1 | 0.2510 | 0.5240 | 2973 | 0.0007 | 0.0009 | 0.0011 | 0.0014 | 0.0016 | 0.0014 |
| 2 | 0.2439 | 0.5155 | 3218 | 0.0008 | 0.0011 | 0.0014 | 0.0016 | 0.0018 | 0.0020 |
| 3 | 0.2459 | 0.5137 | 3176 | 0.0009 | 0.0010 | 0.0013 | 0.0016 | 0.0018 | 0.0021 |
| 4 | 0.2505 | 0.5278 | 2963 | 0.0005 | 0.0008 | 0.0012 | 0.0014 | 0.0015 | 0.0016 |
| 5 | 0.2485 | 0.5231 | 3040 | 0.0004 | 0.0006 | 0.0010 | 0.0014 | 0.0015 | 0.0017 |
| 6 | 0.2482 | 0.5180 | 3083 | 0.0004 | 0.0008 | 0.0012 | 0.0014 | 0.0015 | 0.0016 |
| 7 | 0.2505 | 0.5216 | 3001 | 0.0007 | 0.0011 | 0.0014 | 0.0016 | 0.0017 | 0.0020 |
| 8 | 0.2528 | 0.5263 | 2919 | 0.0007 | 0.0009 | 0.0013 | 0.0016 | 0.0018 | 0.0017 |
| 9 | 0.2496 | 0.5249 | 3002 | 0.0005 | 0.0009 | 0.0012 | 0.0014 | 0.0016 | 0.0016 |
| 10 | 0.2509 | 0.5285 | 2950 | 0.0007 | 0.0009 | 0.0014 | 0.0016 | 0.0017 | 0.0019 |
| 11 | 0.2457 | 0.5139 | 3181 | 0.0008 | 0.0010 | 0.0014 | 0.0017 | 0.0019 | 0.0023 |
| 12 | 0.2460 | 0.5117 | 3190 | 0.0006 | 0.0007 | 0.0012 | 0.0014 | 0.0015 | 0.0019 |
| 13 | 0.2444 | 0.5191 | 3174 | 0.0006 | 0.0009 | 0.0014 | 0.0015 | 0.0018 | 0.0024 |
| 14 | 0.2468 | 0.5166 | 3129 | 0.0008 | 0.0009 | 0.0014 | 0.0017 | 0.0018 | 0.0021 |
| 15 | 0.2465 | 0.5173 | 3133 | 0.0007 | 0.0010 | 0.0015 | 0.0016 | 0.0017 | 0.0018 |
| 16 | 0.2535 | 0.5265 | 2901 | 0.0007 | 0.0008 | 0.0013 | 0.0015 | 0.0016 | 0.0017 |
| 17 | 0.2487 | 0.5193 | 3062 | 0.0007 | 0.0010 | 0.0014 | 0.0016 | 0.0018 | 0.0021 |
| 18 | 0.2471 | 0.5153 | 3130 | 0.0006 | 0.0008 | 0.0012 | 0.0014 | 0.0016 | 0.0019 |
| 19 | 0.2479 | 0.5172 | 3097 | 0.0007 | 0.0009 | 0.0013 | 0.0015 | 0.0018 | 0.0021 |
| 20 | 0.2510 | 0.5223 | 2984 | 0.0007 | 0.0008 | 0.0013 | 0.0015 | 0.0017 | 0.0017 |
| 21 | 0.2525 | 0.5261 | 2926 | 0.0009 | 0.0011 | 0.0013 | 0.0017 | 0.0018 | 0.0020 |
| 22 | 0.2520 | 0.5252 | 2942 | 0.0004 | 0.0006 | 0.0011 | 0.0012 | 0.0014 | 0.0014 |
| 23 | 0.2531 | 0.5248 | 2920 | 0.0007 | 0.0009 | 0.0013 | 0.0016 | 0.0017 | 0.0018 |
| 24 | 0.2433 | 0.5179 | 3213 | 0.0007 | 0.0008 | 0.0013 | 0.0015 | 0.0018 | 0.0018 |
| 25 | 0.2461 | 0.5188 | 3133 | 0.0006 | 0.0008 | 0.0014 | 0.0016 | 0.0017 | 0.0021 |
| Ave. | 0.2487 | 0.5206 | 3058 | 0.0007 | 0.0009 | 0.0013 | 0.0015 | 0.0017 | 0.0019 |
| Med. | 0.2485 | 0.5193 | 3062 | 0.0007 | 0.0009 | 0.0013 | 0.0015 | 0.0017 | 0.0019 |
| st dev | 0.0030 | 0.0049 | 105.5115 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0002 |
| Min. | 0.2433 | 0.5117 | 2901 | 0.0004 | 0.0006 | 0.0010 | 0.0012 | 0.0014 | 0.0014 |
| Max. | 0.2535 | 0.5285 | 3218 | 0.0009 | 0.0011 | 0.0015 | 0.0017 | 0.0019 | 0.0024 |



3.3 Data Set 2, 85 °C, 120 mA (Lumen Maintenance)

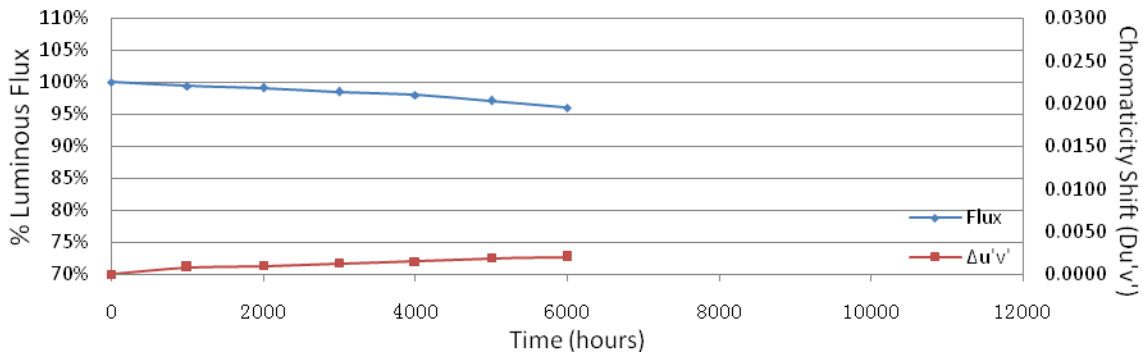
| No. | V _F (V) | Φ(lm) | Lumen Maintenance (%) | | | | | |
|--------|--------------------|--------|-----------------------|---------|---------|---------|---------|---------|
| | 0hr(Initial) | | 1000hrs | 2000hrs | 3000hrs | 4000hrs | 5000hrs | 6000hrs |
| 26 | 2.998 | 43.36 | 99.40 | 99.31 | 98.55 | 98.18 | 97.23 | 95.96 |
| 27 | 3.005 | 43.84 | 99.27 | 99.11 | 98.52 | 98.29 | 97.13 | 95.76 |
| 28 | 3.013 | 43.27 | 99.65 | 99.56 | 98.98 | 98.57 | 97.13 | 96.51 |
| 29 | 3.043 | 43.10 | 99.28 | 99.19 | 98.31 | 97.91 | 97.15 | 95.57 |
| 30 | 3.010 | 43.40 | 99.26 | 99.15 | 98.62 | 98.25 | 97.53 | 95.90 |
| 31 | 3.089 | 42.14 | 99.48 | 99.43 | 98.36 | 97.84 | 97.08 | 95.66 |
| 32 | 2.955 | 43.39 | 99.59 | 99.35 | 98.55 | 98.11 | 97.46 | 95.94 |
| 33 | 3.093 | 43.22 | 99.68 | 99.40 | 98.59 | 98.33 | 97.36 | 96.18 |
| 34 | 3.013 | 43.37 | 99.54 | 99.26 | 98.55 | 98.09 | 96.98 | 95.76 |
| 35 | 2.922 | 43.23 | 99.31 | 99.21 | 98.77 | 97.94 | 97.43 | 96.16 |
| 36 | 2.940 | 43.93 | 99.45 | 99.23 | 98.59 | 97.72 | 96.81 | 95.88 |
| 37 | 2.940 | 43.35 | 99.26 | 99.15 | 98.57 | 97.62 | 96.93 | 96.03 |
| 38 | 2.946 | 43.39 | 99.24 | 99.12 | 98.64 | 97.58 | 96.75 | 95.87 |
| 39 | 3.163 | 43.96 | 99.39 | 99.20 | 98.20 | 97.59 | 96.59 | 95.68 |
| 40 | 3.005 | 43.62 | 99.59 | 99.27 | 98.60 | 97.96 | 97.00 | 96.10 |
| 41 | 2.969 | 43.81 | 99.43 | 99.16 | 98.52 | 97.83 | 96.76 | 95.82 |
| 42 | 3.014 | 43.82 | 99.20 | 98.93 | 98.31 | 97.79 | 96.74 | 95.82 |
| 43 | 2.956 | 43.45 | 99.06 | 98.87 | 98.37 | 97.63 | 96.82 | 95.95 |
| 44 | 2.950 | 43.81 | 99.54 | 98.81 | 98.58 | 97.69 | 96.96 | 95.82 |
| 45 | 3.030 | 43.23 | 99.54 | 98.89 | 98.68 | 98.03 | 97.34 | 96.28 |
| 46 | 2.913 | 43.18 | 99.37 | 98.84 | 98.38 | 98.03 | 97.08 | 95.72 |
| 47 | 3.019 | 43.49 | 99.24 | 98.80 | 98.21 | 97.98 | 97.36 | 96.21 |
| 48 | 2.968 | 43.54 | 99.22 | 98.76 | 98.02 | 97.59 | 97.01 | 96.14 |
| 49 | 2.977 | 43.19 | 99.37 | 98.80 | 98.56 | 98.29 | 97.41 | 96.41 |
| 50 | 2.919 | 43.85 | 99.34 | 98.95 | 98.65 | 98.45 | 97.08 | 96.21 |
| Ave. | 2.994 | 43.438 | 99.39 | 99.11 | 98.51 | 97.97 | 97.09 | 95.97 |
| Med. | 2.998 | 43.390 | 99.37 | 99.15 | 98.55 | 97.96 | 97.08 | 95.94 |
| st dev | 0.0596 | 0.3780 | 0.1580 | 0.2253 | 0.2012 | 0.2867 | 0.2587 | 0.2428 |
| Min. | 2.913 | 42.140 | 99.06 | 98.76 | 98.02 | 97.58 | 96.59 | 95.57 |
| Max. | 3.163 | 43.960 | 99.68 | 99.56 | 98.98 | 98.57 | 97.53 | 96.51 |

TM-21 Projection:

Test Duration: 6000 hours
Failures Observed: 0
α: 6.924E-06
β: 1.004
Calculated L₇₀: 52,000hours
Reported L₇₀: >36,000hours

3.4 Data Set 2, 85 °C, 120mA (Chromaticity Shift)

| No. | u' | v' | CCT(K) | Chromaticity Shift ($\Delta u'v'$) | | | | | |
|--------|--------------|--------|----------|--------------------------------------|---------|---------|---------|---------|---------|
| | 0hr(Initial) | | | 1000hrs | 2000hrs | 3000hrs | 4000hrs | 5000hrs | 6000hrs |
| 26 | 0.2452 | 0.5124 | 3207 | 0.0006 | 0.0010 | 0.0014 | 0.0017 | 0.0019 | 0.0023 |
| 27 | 0.2488 | 0.5221 | 3040 | 0.0009 | 0.0010 | 0.0013 | 0.0015 | 0.0019 | 0.0020 |
| 28 | 0.2526 | 0.5259 | 2925 | 0.0008 | 0.0009 | 0.0013 | 0.0015 | 0.0017 | 0.0018 |
| 29 | 0.2451 | 0.5139 | 3198 | 0.0007 | 0.0008 | 0.0012 | 0.0014 | 0.0019 | 0.0021 |
| 30 | 0.2509 | 0.5217 | 2989 | 0.0006 | 0.0007 | 0.0011 | 0.0012 | 0.0016 | 0.0017 |
| 31 | 0.2450 | 0.5125 | 3213 | 0.0006 | 0.0007 | 0.0011 | 0.0012 | 0.0018 | 0.0018 |
| 32 | 0.2455 | 0.5124 | 3197 | 0.0006 | 0.0007 | 0.0010 | 0.0012 | 0.0017 | 0.0017 |
| 33 | 0.2459 | 0.5106 | 3202 | 0.0008 | 0.0010 | 0.0012 | 0.0015 | 0.0020 | 0.0021 |
| 34 | 0.2454 | 0.5141 | 3186 | 0.0010 | 0.0012 | 0.0014 | 0.0017 | 0.0021 | 0.0022 |
| 35 | 0.2537 | 0.5279 | 2889 | 0.0009 | 0.0010 | 0.0012 | 0.0017 | 0.0017 | 0.0017 |
| 36 | 0.2514 | 0.5236 | 2965 | 0.0012 | 0.0013 | 0.0013 | 0.0016 | 0.0019 | 0.0019 |
| 37 | 0.2531 | 0.5265 | 2910 | 0.0009 | 0.0012 | 0.0012 | 0.0016 | 0.0017 | 0.0017 |
| 38 | 0.2462 | 0.5147 | 3160 | 0.0007 | 0.0011 | 0.0013 | 0.0014 | 0.0019 | 0.0017 |
| 39 | 0.2473 | 0.5168 | 3116 | 0.0009 | 0.0012 | 0.0015 | 0.0017 | 0.0020 | 0.0019 |
| 40 | 0.2514 | 0.5247 | 2960 | 0.0010 | 0.0012 | 0.0015 | 0.0017 | 0.0019 | 0.0018 |
| 41 | 0.2512 | 0.5256 | 2960 | 0.0009 | 0.0011 | 0.0015 | 0.0015 | 0.0019 | 0.0017 |
| 42 | 0.2527 | 0.5275 | 2913 | 0.0010 | 0.0010 | 0.0013 | 0.0016 | 0.0018 | 0.0017 |
| 43 | 0.2516 | 0.5236 | 2961 | 0.0009 | 0.0011 | 0.0014 | 0.0017 | 0.0019 | 0.0017 |
| 44 | 0.2500 | 0.5256 | 2988 | 0.0008 | 0.0009 | 0.0014 | 0.0017 | 0.0020 | 0.0020 |
| 45 | 0.2548 | 0.5284 | 2870 | 0.0010 | 0.0011 | 0.0015 | 0.0017 | 0.0019 | 0.0017 |
| 46 | 0.2513 | 0.5229 | 2974 | 0.0009 | 0.0009 | 0.0012 | 0.0016 | 0.0018 | 0.0016 |
| 47 | 0.2461 | 0.5140 | 3169 | 0.0008 | 0.0010 | 0.0014 | 0.0015 | 0.0020 | 0.0022 |
| 48 | 0.2465 | 0.5138 | 3159 | 0.0009 | 0.0012 | 0.0015 | 0.0016 | 0.0027 | 0.0028 |
| 49 | 0.2437 | 0.5076 | 3213 | 0.0008 | 0.0009 | 0.0012 | 0.0014 | 0.0022 | 0.0025 |
| 50 | 0.2436 | 0.5163 | 3219 | 0.0006 | 0.0007 | 0.0010 | 0.0011 | 0.0019 | 0.0024 |
| Ave. | 0.2488 | 0.5194 | 3063 | 0.0008 | 0.0010 | 0.0013 | 0.0015 | 0.0019 | 0.0020 |
| Med. | 0.2488 | 0.5217 | 3040 | 0.0009 | 0.0010 | 0.0013 | 0.0016 | 0.0019 | 0.0018 |
| st dev | 0.0035 | 0.0064 | 126.9228 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0002 | 0.0003 |
| Min. | 0.2436 | 0.5076 | 2870 | 0.0006 | 0.0007 | 0.0010 | 0.0011 | 0.0016 | 0.0016 |
| Max. | 0.2548 | 0.5284 | 3219 | 0.0012 | 0.0013 | 0.0015 | 0.0017 | 0.0027 | 0.0028 |



3.5 Data Set 3, 105 °C, 120 mA (Lumen Maintenance)

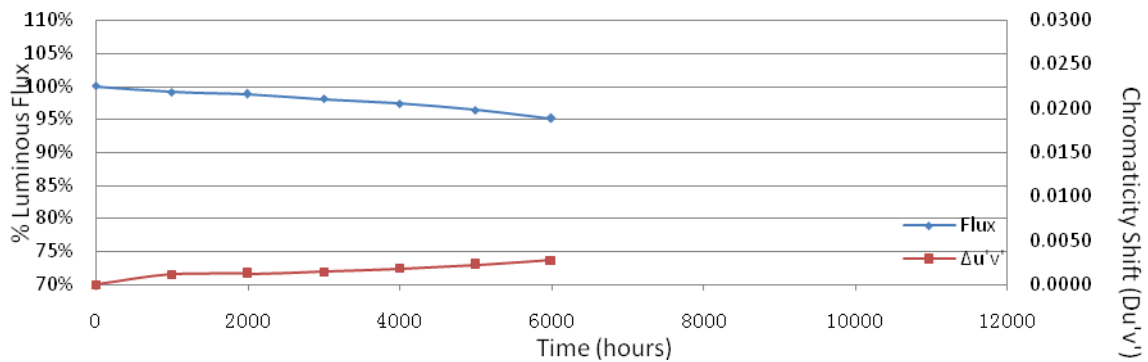
| No. | V _F (V) | Φ(lm) | Lumen Maintenance (%) | | | | | |
|--------|--------------------|--------|-----------------------|---------|---------|---------|---------|---------|
| | 0hr(Initial) | | 1000hrs | 2000hrs | 3000hrs | 4000hrs | 5000hrs | 6000hrs |
| 51 | 2.970 | 43.21 | 99.12 | 98.94 | 98.50 | 97.76 | 96.71 | 96.16 |
| 52 | 2.935 | 43.65 | 99.04 | 98.74 | 98.33 | 97.59 | 96.45 | 95.37 |
| 53 | 3.057 | 43.33 | 98.96 | 98.75 | 97.62 | 96.98 | 95.92 | 94.76 |
| 54 | 2.975 | 43.45 | 99.38 | 98.87 | 98.20 | 97.61 | 96.78 | 95.67 |
| 55 | 2.905 | 43.29 | 98.94 | 98.80 | 98.18 | 97.27 | 96.67 | 94.66 |
| 56 | 2.958 | 43.19 | 99.03 | 98.70 | 98.47 | 97.48 | 96.36 | 95.02 |
| 57 | 2.983 | 43.26 | 99.10 | 98.89 | 98.50 | 97.62 | 96.46 | 94.91 |
| 58 | 3.000 | 43.53 | 98.99 | 98.71 | 97.77 | 97.04 | 96.35 | 94.90 |
| 59 | 2.982 | 44.09 | 99.41 | 98.93 | 98.19 | 97.85 | 96.30 | 95.40 |
| 60 | 3.029 | 43.79 | 99.11 | 98.95 | 98.40 | 97.49 | 96.99 | 95.94 |
| 61 | 3.021 | 43.35 | 98.87 | 98.75 | 98.13 | 97.62 | 96.66 | 95.94 |
| 62 | 2.993 | 43.68 | 98.88 | 98.67 | 97.73 | 97.16 | 96.25 | 95.40 |
| 63 | 2.959 | 43.47 | 99.06 | 98.60 | 97.81 | 97.26 | 96.71 | 95.88 |
| 64 | 2.921 | 43.14 | 99.26 | 98.73 | 98.01 | 97.43 | 96.69 | 95.41 |
| 65 | 2.991 | 44.04 | 99.25 | 98.61 | 97.87 | 97.28 | 96.55 | 95.19 |
| 66 | 3.042 | 43.17 | 99.31 | 98.73 | 98.01 | 97.50 | 96.59 | 95.46 |
| 67 | 2.990 | 43.25 | 99.33 | 98.91 | 97.94 | 97.48 | 96.25 | 95.24 |
| 68 | 2.956 | 44.51 | 99.35 | 98.72 | 97.93 | 97.28 | 96.25 | 95.39 |
| 69 | 3.055 | 43.31 | 99.21 | 98.78 | 97.58 | 96.91 | 96.03 | 95.11 |
| 70 | 3.095 | 43.77 | 98.99 | 98.63 | 97.83 | 97.26 | 96.41 | 94.59 |
| 71 | 2.954 | 43.31 | 98.87 | 98.66 | 97.92 | 96.93 | 95.84 | 93.86 |
| 72 | 3.098 | 43.75 | 99.29 | 98.81 | 98.56 | 97.76 | 96.18 | 94.19 |
| 73 | 2.921 | 43.52 | 98.87 | 98.67 | 98.14 | 97.13 | 96.35 | 94.62 |
| 74 | 2.960 | 43.21 | 99.03 | 98.84 | 97.82 | 97.08 | 96.14 | 95.16 |
| 75 | 2.952 | 43.58 | 99.08 | 98.94 | 97.96 | 97.59 | 96.21 | 94.08 |
| Ave. | 2.988 | 43.514 | 99.11 | 98.77 | 98.06 | 97.37 | 96.40 | 95.13 |
| Med. | 2.982 | 43.450 | 99.08 | 98.75 | 98.01 | 97.43 | 96.36 | 95.19 |
| st dev | 0.0516 | 0.3373 | 0.1731 | 0.1102 | 0.2841 | 0.2719 | 0.2804 | 0.5885 |
| Min. | 2.905 | 43.140 | 98.87 | 98.60 | 97.58 | 96.91 | 95.84 | 93.86 |
| Max. | 3.098 | 44.510 | 99.41 | 98.95 | 98.56 | 97.85 | 96.99 | 96.16 |

TM-21 Projection:

Test Duration: 6000 hours
Failures Observed: 0
α: 8.139E-06
β: 1.003
Calculated L₇₀: 44,000 hours
Reported L₇₀: >36,000 hours

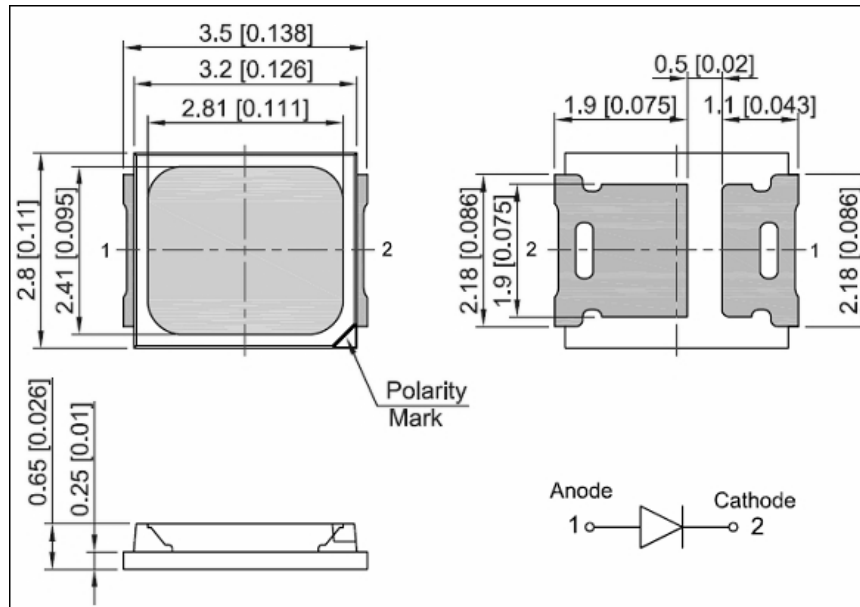
3.6 Data Set 3, 105 °C, 120 mA (Chromaticity Shift)

| No. | u' | v' | CCT(K) | Chromaticity Shift ($\Delta u'v'$) | | | | | |
|--------|--------------|--------|----------|--------------------------------------|---------|---------|---------|---------|---------|
| | 0hr(Initial) | | | 1000hrs | 2000hrs | 3000hrs | 4000hrs | 5000hrs | 6000hrs |
| 51 | 0.2530 | 0.5267 | 2911 | 0.0010 | 0.0012 | 0.0014 | 0.0017 | 0.0023 | 0.0023 |
| 52 | 0.2539 | 0.5279 | 2884 | 0.0010 | 0.0011 | 0.0015 | 0.0017 | 0.0022 | 0.0024 |
| 53 | 0.2447 | 0.5165 | 3189 | 0.0010 | 0.0012 | 0.0015 | 0.0020 | 0.0024 | 0.0028 |
| 54 | 0.2524 | 0.5248 | 2936 | 0.0013 | 0.0013 | 0.0015 | 0.0019 | 0.0022 | 0.0026 |
| 55 | 0.2465 | 0.5189 | 3121 | 0.0007 | 0.0008 | 0.0010 | 0.0015 | 0.0017 | 0.0022 |
| 56 | 0.2460 | 0.5151 | 3162 | 0.0009 | 0.0011 | 0.0013 | 0.0017 | 0.0021 | 0.0030 |
| 57 | 0.2462 | 0.5209 | 3114 | 0.0008 | 0.0009 | 0.0011 | 0.0016 | 0.0019 | 0.0025 |
| 58 | 0.2449 | 0.5177 | 3173 | 0.0009 | 0.0010 | 0.0013 | 0.0018 | 0.0020 | 0.0027 |
| 59 | 0.2507 | 0.5248 | 2977 | 0.0011 | 0.0012 | 0.0015 | 0.0018 | 0.0024 | 0.0026 |
| 60 | 0.2506 | 0.5236 | 2985 | 0.0009 | 0.0011 | 0.0015 | 0.0018 | 0.0022 | 0.0025 |
| 61 | 0.2456 | 0.5131 | 3189 | 0.0011 | 0.0009 | 0.0014 | 0.0017 | 0.0021 | 0.0025 |
| 62 | 0.2450 | 0.5144 | 3197 | 0.0012 | 0.0012 | 0.0014 | 0.0020 | 0.0025 | 0.0031 |
| 63 | 0.2539 | 0.5273 | 2887 | 0.0012 | 0.0014 | 0.0014 | 0.0019 | 0.0023 | 0.0026 |
| 64 | 0.2479 | 0.5164 | 3101 | 0.0012 | 0.0012 | 0.0015 | 0.0016 | 0.0022 | 0.0029 |
| 65 | 0.2458 | 0.5156 | 3164 | 0.0011 | 0.0013 | 0.0016 | 0.0017 | 0.0024 | 0.0027 |
| 66 | 0.2484 | 0.5171 | 3083 | 0.0012 | 0.0012 | 0.0015 | 0.0016 | 0.0022 | 0.0027 |
| 67 | 0.2468 | 0.5163 | 3133 | 0.0014 | 0.0014 | 0.0015 | 0.0018 | 0.0025 | 0.0033 |
| 68 | 0.2472 | 0.5227 | 3076 | 0.0011 | 0.0012 | 0.0012 | 0.0016 | 0.0021 | 0.0025 |
| 69 | 0.2470 | 0.5131 | 3150 | 0.0010 | 0.0012 | 0.0011 | 0.0016 | 0.0021 | 0.0027 |
| 70 | 0.2458 | 0.5128 | 3188 | 0.0013 | 0.0014 | 0.0016 | 0.0016 | 0.0024 | 0.0030 |
| 71 | 0.2455 | 0.5138 | 3186 | 0.0011 | 0.0011 | 0.0014 | 0.0017 | 0.0022 | 0.0026 |
| 72 | 0.2501 | 0.5209 | 3016 | 0.0013 | 0.0014 | 0.0016 | 0.0018 | 0.0023 | 0.0028 |
| 73 | 0.2530 | 0.5264 | 2914 | 0.0008 | 0.0013 | 0.0015 | 0.0018 | 0.0021 | 0.0025 |
| 74 | 0.2521 | 0.5247 | 2943 | 0.0010 | 0.0013 | 0.0015 | 0.0018 | 0.0023 | 0.0027 |
| 75 | 0.2456 | 0.5198 | 3138 | 0.0012 | 0.0014 | 0.0016 | 0.0020 | 0.0024 | 0.0028 |
| Ave. | 0.2483 | 0.5197 | 3073 | 0.0011 | 0.0012 | 0.0014 | 0.0018 | 0.0022 | 0.0027 |
| Med. | 0.2470 | 0.5189 | 3114 | 0.0011 | 0.0012 | 0.0015 | 0.0017 | 0.0022 | 0.0027 |
| st dev | 0.0032 | 0.0050 | 110.0821 | 0.0002 | 0.0002 | 0.0002 | 0.0001 | 0.0002 | 0.0002 |
| Min. | 0.2447 | 0.5128 | 2884 | 0.0007 | 0.0008 | 0.0010 | 0.0015 | 0.0017 | 0.0022 |
| Max. | 0.2539 | 0.5279 | 3197 | 0.0014 | 0.0014 | 0.0016 | 0.0020 | 0.0025 | 0.0033 |



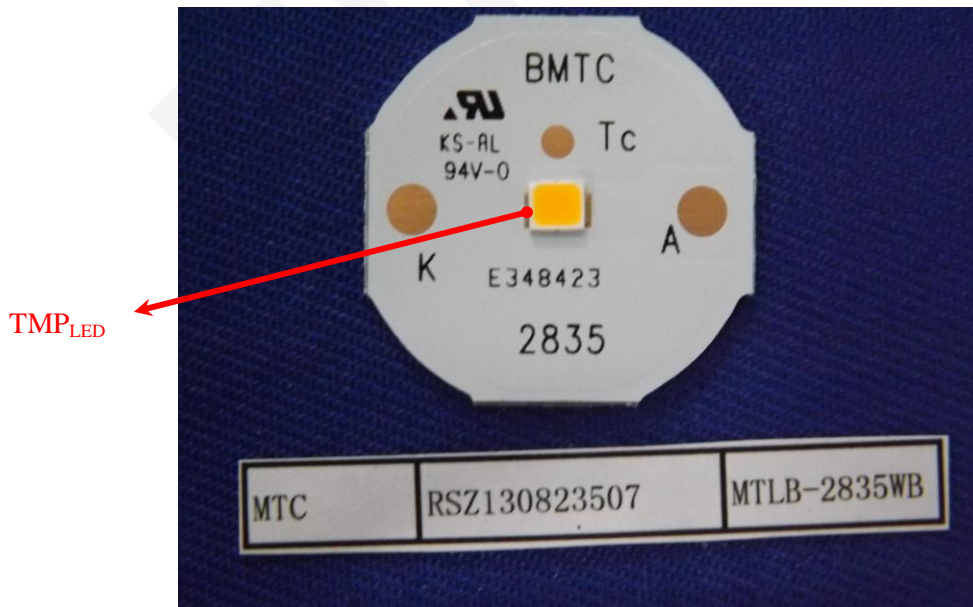
Appendix A – EUT PHOTO

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



All dimensions are in millimeter

A.2 EUT Photo



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