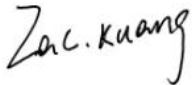



Test report of ENERGY STAR® Program Requirements for Luminaires V2.0-Directional Luminaires

| | |
|-----------------------------|--|
| Report Number: | BL180227001-9 |
| Report Type: | Final report |
| Test Date: | 2017-04-25 to 2017-05-22 |
| Report Date: | 2018-02-28 |
| Product Model: | T5LCLT * |
| Product Type: | Direction residential indoor, under cabinet luminaires, Dimmable |
| Product Description: | 120V/60Hz/9W CCT: 3000K 3500K 4000K |
| Applicant: | AFX Inc. |
| Applicant Address: | 2345 N. Ernie Krueger Circle Waukegan, IL 60087 |
| Brand Name: | AFX |
| Manufacture: | Foshan Innovative Lighting Co.,LTD. |
| Manufacture Address: | Dajin Industrial Area, Danzao, Nanhai, Foshan, Guangdong, 528216.China |
| Product Criteria: | ENERGY STAR® Program Requirements for Luminaires ---V2.0 |
| Test laboratory: | Shenzhen Belling Efficiency Testing Lab |
| Lab Location: | 1/F., Building 1, 1F, No.1 building, Meibaohe industrial park, Dalang street, Shenzhen, Guangdong Prov.518101, China. |
| | Tel: (86) 755-21038430 |
| Tested By: | Zac Kuang  |
| Reviewed By: | Jason Zhou  |

Note 1: 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 use in part without prior written consent from Shenzhen Belling Efficiency Testing Lab. This report must not be used by the customer to claim product certification, approval, or endorsement By NVLAP, NIST, or any agency of the U.S. Government.

Note 2: This report contains data that are not covered by the NVLAP accreditation. See the following description: Frequency, noise, overall length and diameter test are not in NVLAP accreditation scope.

Reference standards or methods

| | |
|-------------------------------------|---|
| ANSI/NEMA/ANSLG C78.377-2015 | Specifications for the Chromaticity of Solid State Lighting Products |
| ANSI/ANSLG C81.61-2009 | Specifications for Bases (Caps) for Electric Lamps |
| ANSI/ANSLG C81.62-2009 | Lamp holders for Electric Lamps |
| ANSI C82.77-10-2014 | Harmonic Emmission Limits-Related Power Quality Requirements for Lighting Equipment |
| ANSI/IEEE C62.41.1-2002 | IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits |
| ANSI/IEEE C62.41.2-2002 | IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000V and Less) AC Power Circuits |
| ANSI/UL 153-2008 | Portable Electric Luminaires |
| ANSI/UL 1993-2011 | Self-Ballasted Lamps and Lamp Adapters |
| ANSI/UL 8750-2009 | Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products |
| CIE 15-200:2004 | Colorimetry |
| CIE Pub. No. 13-1995 | Method of Measuring and Specifying Color Rendering of Light Sources |
| IES LM-79-08 | Electrical and Photometric Measurements of Solid-State Lighting Products |
| IES LM-80-08 | Measuring Lumen Maintenance of LED Light Sources |
| IES LM-82-12 | IES Approved Method for the Characterization of LED Light Engines and Integrated LED Lamps for Electrical and Photometric Properties as a Function of Temperature |

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1 – General Information

| Product Family and Allowable Variations | | | | |
|---|-----------------|----------------------|----------------------|----------------------|
| General information | Basic Model | Allowable Variations | Allowable Variations | Allowable Variations |
| Model Name | T5LCLT *(3000K) | T5LCLT *(3500K) | T5LCLT *(4000K) | - |
| CCT | 3000K | 3500K | 4000K | - |
| Rate Input | AC 120V 60Hz | | | |
| Nominal Lamp Power | 9W | | | |
| Nominal Light Output | 460 lm | | | |
| Nominal CRI(Ra) | >90 | | | |
| Nominal Lamp Life | 50000hrs | | | |

1.1 Light source components description

| Light source components | Manufacture | Model |
|-------------------------|--|--------------------|
| LED Package | Shenzhen Smalite Semiconductor Co.,Ltd | SL-IB2835FTA-31KAG |

1.2 Test Equipment List and Details

| Device | Manufacture | Model No. | Serial No. | Calibration due date |
|---|-------------|-----------|------------|----------------------|
| Goniophotometric System | SENSING | GMS-3000 | N.A | 2018-09-20 |
| AC Power Source | ALL POWER | APW-110N | 992257 | 2018-08-26 |
| Total Luminous Flux Standard Lamp | SENSING | 110V/100W | S13100234 | 2018-09-14 |
| Digital Power Meter | YOKOGAWA | WT310 | C2QM02030V | 2018-08-28 |
| Integral Sphere | SENSING | SPR-600M | N.A | 2018-08-26 |
| Integral Sphere (2M) | SENSING | SD-20 | N.A | 2018-08-26 |
| Digital Power Meter | YOKOGAWA | WT210 | 91L929742 | 2018-08-28 |
| Optical Color and Electrical Measurement System | SENSING | SPR-3000 | N.A | 2018-08-26 |
| Temperature/humidity/clock | VICTOR | VC230 | 57636 | 2018-09-12 |
| Digital Anemometer | TECMAN | TD8901 | 026141 | 2018-09-12 |

Statement of Traceability: Shenzhen Belling Efficiency Testing Lab attests that all calibration has been performed using suitable standards traceable to national primary standards and International System of Unit (SI).

1.3 Description

- Declaration: AFX Inc. declare that their product with model T5LCLT * is the same to the product in the report BL180227001-9 and is authorized by original applicant to use their test data.
- Note: All the data in previous report BL180227001-9 is shared in report.

2 – SUMMARY OF TEST RESULT

2.1 For Directionals Luminaires

| Item | Measured | Result | Requirement |
|---|--|--------|--|
| Luminaire Efficacy (initial) | 53.842 lm/w | pass | ≥ 50 lm/w |
| Luminaire Light Output (initial) | 479.732 lm | pass | Luminaire shall deliver a minimum of 125 lumens per lineal foot. The minimum required light output (in lumens) is calculated by dividing the measured luminaire length in inches by 12, then multiplying the result by 125. |
| Luminaire Zonal Lumen Density | 73.871% | PASS | $\geq 60\%$ (0-60°) |
| Light Source Life and Lumen Maintenance | >60000 | pass | $\geq L70$ lumen maintenance life values: 25,000 hours for residential grade indoor luminaires |
| Correlated Color Temperature | 3103 K | pass | Lamps shall have one of correlated color temperatures 2700, 3000, 3500, 4000Kelvin, 5000 corresponding 7-step chromaticity quadrangles as defined in ANSI/NEMA/ANSI C78.377-2015. |
| CRI(Ra) | Ra=92.7 R9=67 | pass | Ra ≥ 80 R9>0 |
| Color Maintenance | 0.0035 | pass | ≤ 0.007 (For Solid State Indoor Luminaires Only) |
| Color Angular Uniformity | 0.0025 | pass | $\Delta u', v' \leq 0.006$ |
| Source Start Time(ms) | 388 ms 1 complete luminaires measured | pass | ≤ 750 ms Samples shall pass. |

| | | | |
|--|---|------|--|
| Dimming Requirements | Noise Test 20% light output: 18.1 dBA | pass | The luminaire and its components shall provide continuous dimming from 100% to 20% of light output. ≤ 24 dBA at 1 meter or less Samples shall pass. |
| Power Factor | 0.981 1 complete luminaires measured | pass | Total luminaire input power ≤ 5 watts: PF ≥ 0.5 Total luminaire input power > 5 watts: PF ≥ 0.7 All samples shall pass. |
| Standby Power Consumption | 0.0 W 1 complete luminaire measured | pass | Luminaires incorporating an integral method of switching shall not draw power in the off state. |
| Transient Protection | 1 complete luminaires measured. | pass | The line transient shall consist of seven strikes of a 100 kHz ring wave, 2.5 kV level, for both common mode and differential mode. All samples shall pass. |
| Operating Frequency | 121.4Hz 1 complete luminaire measured. | pass | Frequency ≥ 120 Hz. All samples shall pass. |
| Maximum Driver Case Temperature | 46.9°C 1 complete luminaire measured. | pass | Measured temperature at the TMPC shall be less than or equal to the manufacturer recommended temperature |

Note: The test data was only good for the test sample. It may have deviation for other test sample.

3 – Test Method

3.1 Initial Photometric and Electrical Parameters

2.1.1 The samples were tested with no seasoning. Before measurements were taken, the sample was operated for about 2 hours to reach stabilization and temperature equilibrium. It was 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 30min, taken 15 minutes apart, is less than 0.5%. The ambient temperature in the whole test process was kept in $25\pm 1^{\circ}\text{C}$, and the samples were in its designated orientation for all the measurements.

3.1.2 The samples were first subjected to color, lumen output and electrical parameters measurement by spectroradiometer with 2 meters integrated sphere (4π) and power analyzer.

3.1.3 After integrated sphere test, one of the samples was removed to a mirror-type goniophotometer (Type C) with photometer ($f1 < 1.5\%$) for light distribution test. The angle interval was settled based on the sample beam angle, and horizontal angle interval was 15° , vertical angle interval was 5° .

3.1.4 After luminous intensity distribution test, the same sample was subjected to color spatial uniformity measurement by the same goniophotometer with another colorimeter. The horizontal angle interval was 90° , however the vertical was 1° .

3.2 Minimum Starting Temperature

The samples were placed in chamber of -18°C to verify if can be normally operated or not. A low temperature chamber was used for the measurement.

3.3 Start Time Test

3.3.1 Start time was measured by digital oscilloscope and photometer.

3.3.2 The ambient temperature in the whole test process was kept in $25\pm 1^{\circ}\text{C}$, and the samples were in its designated orientation for start time test.

3.4 In Situ Temperature Measurement Test

3.4.1 The LED module and driver used in the luminaire were tested in accordance with ANSI/UL 153-2008 and ANSI/UL 8750-2009.

3.4.2 Thermocouples were in contact with the TMLED location described in LM-80 test report and TMPC location of LED driver as detailed by manufacture. In order to gain the maximum temperature, if appropriate, more than one thermocouple was contact in these locations.

3.4.3 The sample was mounted in the test alcove, in contact with the two walls and top of the alcove which in accordance with UL 153.

3.4.4 The sample was operated for 7.5 hours to obtain constant temperatures, an Agilent data logger was used for data recording.

3.4.5 The ambient temperature was kept in $25\pm 5^{\circ}\text{C}$, and final measured values were normalized to an ambient of 25°C . The sample was in its designated orientation.

3.5 Transient Protection Test

3.5.1 The line transient was consisting of seven strikes of a 100 kHz ring wave, 2.5 kV level, for both common mode and differential mode.

3.5.2 The ambient temperature was kept in $25\pm 5^{\circ}\text{C}$, and the sample was in its designated orientation.

3.6 Operating Frequency

3.6.1 The sample light output waveform was measured by oscilloscope with a photodetector.

3.6.2 The test was conducted at normal operation and dimming operation at all light output levels.

3.6.3 The ambient temperature was kept in $25\pm 1^{\circ}\text{C}$, and the sample was in its designated orientation.

3.7 Audible Noise Test

3.7.1 The sample was operated in centre of an anechoic room with a background noise lower than 15 dBA. The microphone was located in 30 cm distance from center of the sample in different directions, and maximum value was used as the test result.

3.7.2 The ambient temperature was kept in $25\pm 5^{\circ}\text{C}$, and the sample was in its designated orientation.

3.8 Dimming test

3.8.1 The sample was connected with a customer recommended dimmer firstly.

3.8.2 Then adjust the dimmer to measure the light output dimming range by a photometer.

3.8.3 The ambient temperature was kept in $25\pm 1^{\circ}\text{C}$, and the sample was in its designated orientation.

4 – Test Data

4.1 Photometric and Electrical Data

| Model No. | Power (W) | Current (A) | PF | CCT (K) | CRI | R9 | Luminaire Efficacy (lm/w) | Light output(lm) | x | y |
|-----------------|-----------|-------------|-------|---------|------|----|---------------------------|------------------|--------|--------|
| T5LCLT *(3000K) | 8.91 | 0.076 | 0.981 | 3103 | 92.7 | 67 | 53.842 | 479.732 | 0.4280 | 0.3976 |

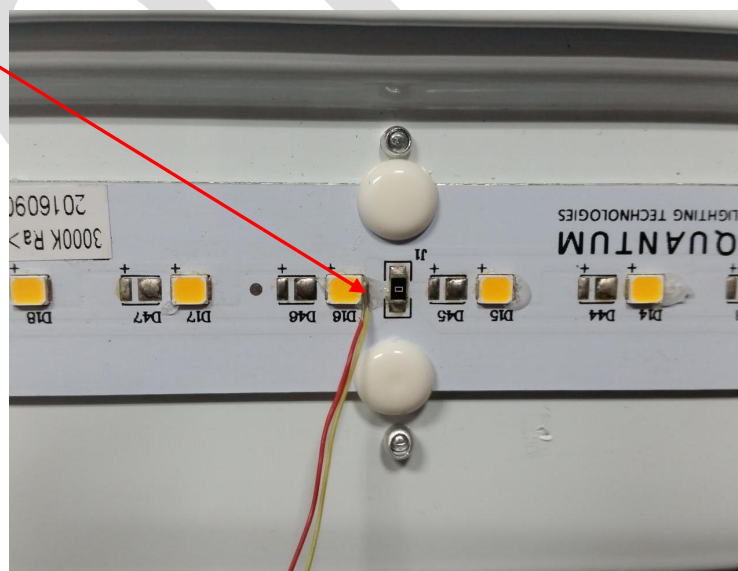
4.2 Color Angular Uniformity Test

| Sample No. | Maximum $\Delta u'v'$ |
|------------|-----------------------|
| S1 | 0.0025 |

4.3 In Situ Temperature Test (ISTMT)

| TMP verification of LEDs inside luminaires + declared drive current | | | | |
|---|--|---------------------------|--|--|
| Sample No. | TMP verification of LEDs inside luminaires | | Declared drive current of LEDs inside luminaires | |
| S1 | Measured T_{S1} (°C) | LM-80 Reported T_s (°C) | Measured(mA) | Lm-80 Declared Driver Current of LED(mA) |
| | 62.8 | 85 | 88.6 | 100 |
| Result | 62.8°C < 85°C PASS | | 88.6mA < 100mA PASS | |

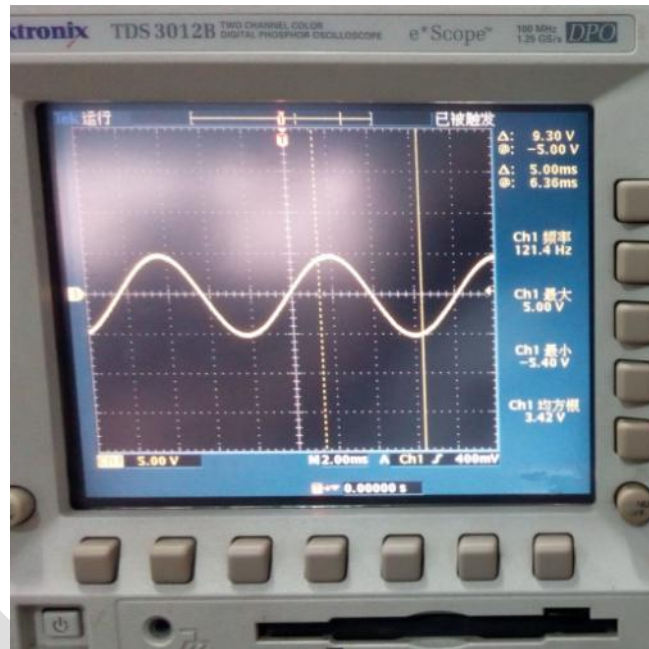
T_{S1} location



4.4 LED Operating Frequency, Noise Test.

| Sample No. | LED Operating Frequency (Hz) | Noise Test |
|------------|------------------------------|------------|
| S1 | 121.4 | 18.1 dBA |

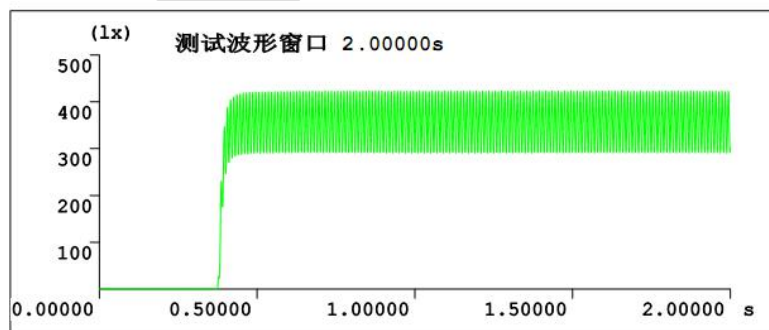
Attachment of frequency



4.5 Source Start Time Data

| Sample No. | Start time (ms) |
|------------|-----------------|
| S1 | 388 |

Attachment of star time test



starting time :0.388s

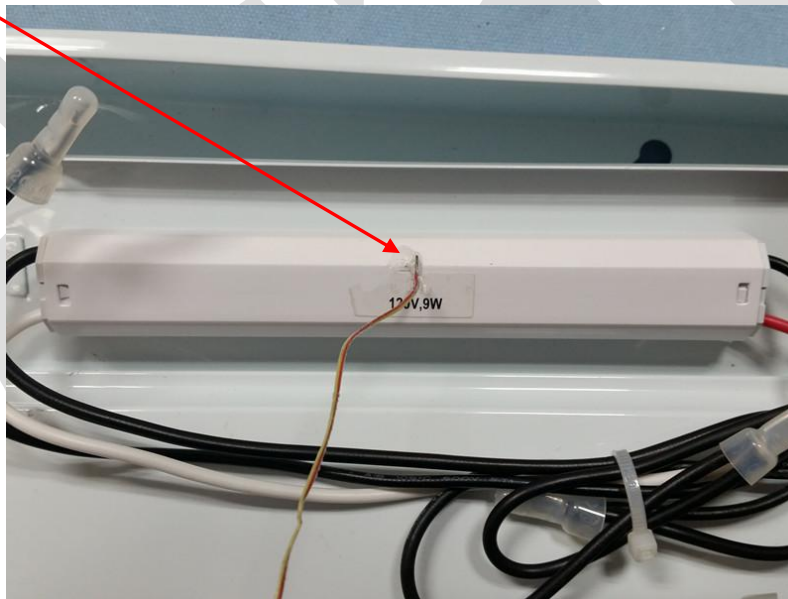
4.6 Transient Protection Test

| Sample No. | Transient Protection Test |
|------------|---------------------------|
| S1 | PASS |

4.7 Maximum Measured Ballast or Driver Case Temperature Test

| Maximum Measured Ballast or Driver Case Temperature | | |
|---|-------------------------------|--|
| Sample No. | Maximum Temperature Test (°C) | Manufacturer Recommended Temperature(°C) |
| S1 | 46.9 | 75 |
| Result | 46.9°C < 75°C PASS | |

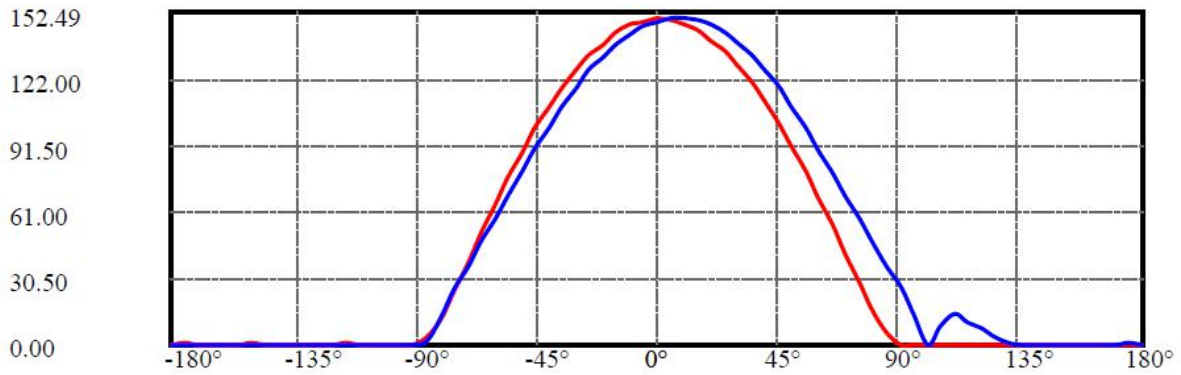
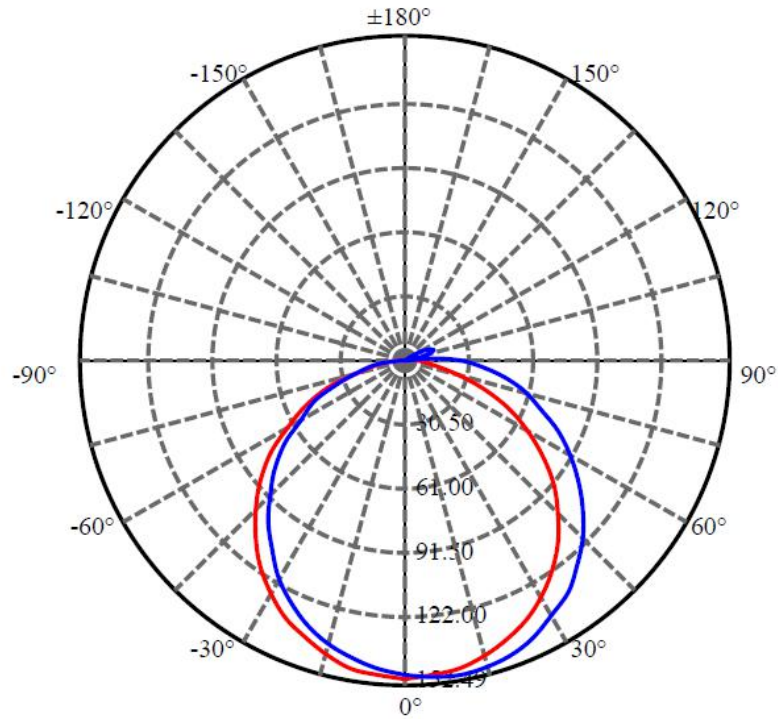
Case Temperature Point



4.8 Dimming Test

| Sample NO. | Dimming range |
|------------|---------------|
| S1 | 10% to 100% |

Attachment A – Luminous Intensity Distribution



C0/C180: —

C90/C270: —

Field angle(10%Imax):C0/180Left:79.0 Right:80.5

:C90/270Left:89.4 Right:84.6

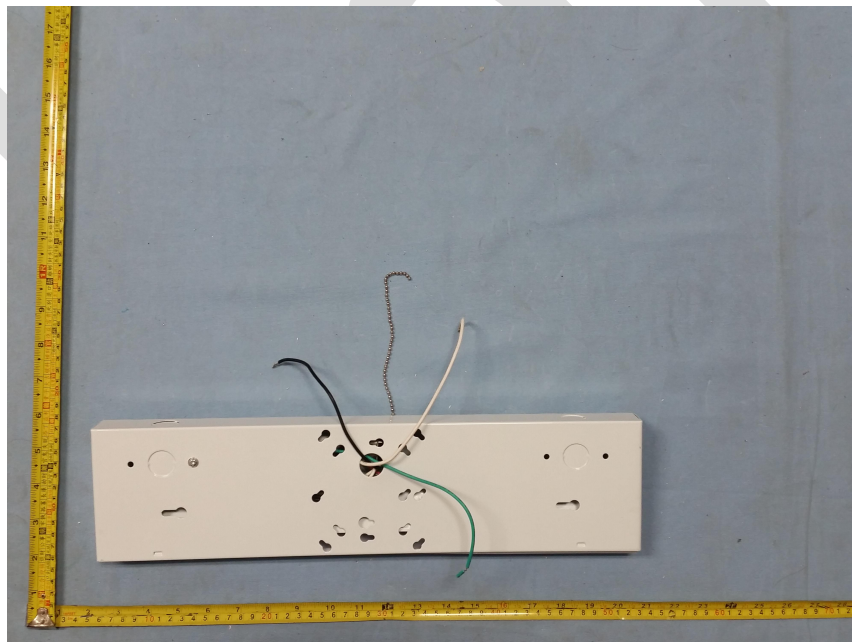
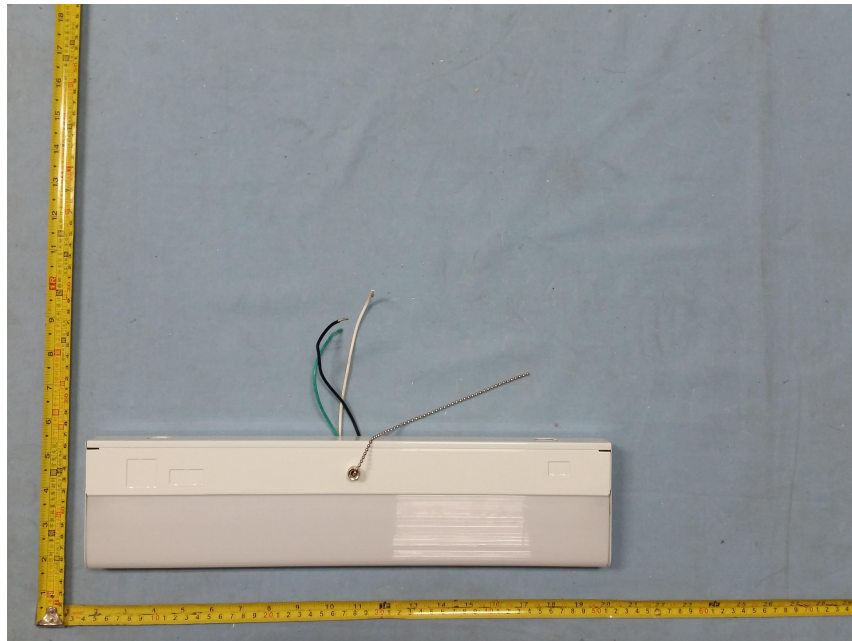
Beam Angle(50%Imax):C0/180Left:55.8 Right:57.1

:C90/270Left:62.1 Right:56.9

Zonal Flux Diagram

| $\gamma(^{\circ})$ | Average I(cd) | Zonal F(lm) | Sum F(lm) | Eff Flux(%) | Eff Sum(%) |
|--------------------|---------------|-------------|-----------|-------------|------------|
| 0.0 | 148.996 | .000 | .000 | .000% | .000% |
| 5.0 | 148.566 | 3.557 | 3.557 | .763% | .763% |
| 10.0 | 146.906 | 10.570 | 14.127 | 2.269% | 3.032% |
| 15.0 | 143.912 | 17.251 | 31.378 | 3.703% | 6.735% |
| 20.0 | 139.658 | 23.370 | 54.748 | 5.016% | 11.751% |
| 25.0 | 134.410 | 28.745 | 83.493 | 6.169% | 17.920% |
| 30.0 | 127.948 | 33.202 | 116.695 | 7.126% | 25.046% |
| 35.0 | 120.359 | 36.565 | 153.260 | 7.848% | 32.894% |
| 40.0 | 111.865 | 38.745 | 192.005 | 8.316% | 41.210% |
| 45.0 | 102.527 | 39.697 | 231.701 | 8.520% | 49.730% |
| 50.0 | 92.507 | 39.410 | 271.111 | 8.458% | 58.188% |
| 55.0 | 81.791 | 37.898 | 309.009 | 8.134% | 66.322% |
| 60.0 | 70.363 | 35.170 | 344.179 | 7.548% | 73.871% |
| 65.0 | 58.786 | 31.396 | 375.575 | 6.739% | 80.609% |
| 70.0 | 47.091 | 26.809 | 402.384 | 5.754% | 86.363% |
| 75.0 | 35.589 | 21.611 | 423.995 | 4.638% | 91.002% |
| 80.0 | 24.472 | 16.071 | 440.065 | 3.449% | 94.451% |
| 85.0 | 13.740 | 10.383 | 450.449 | 2.229% | 96.679% |
| 90.0 | 7.767 | 5.889 | 456.338 | 1.264% | 97.943% |
| 95.0 | 2.950 | 2.934 | 459.272 | .630% | 98.573% |
| 100.0 | .815 | 1.023 | 460.295 | .220% | 98.793% |
| 105.0 | 2.979 | 1.015 | 461.310 | .218% | 99.011% |
| 110.0 | 3.113 | 1.592 | 462.902 | .342% | 99.352% |
| 115.0 | 2.238 | 1.355 | 464.257 | .291% | 99.643% |
| 120.0 | 1.334 | .868 | 465.126 | .186% | 99.830% |
| 125.0 | .593 | .445 | 465.571 | .096% | 99.925% |
| 130.0 | .089 | .148 | 465.719 | .032% | 99.957% |
| 135.0 | .104 | .039 | 465.758 | .008% | 99.965% |
| 140.0 | .089 | .036 | 465.794 | .008% | 99.973% |
| 145.0 | .059 | .025 | 465.819 | .005% | 99.978% |
| 150.0 | .074 | .020 | 465.838 | .004% | 99.982% |
| 155.0 | .030 | .013 | 465.851 | .003% | 99.985% |
| 160.0 | .133 | .017 | 465.868 | .004% | 99.989% |
| 165.0 | .119 | .021 | 465.889 | .004% | 99.993% |
| 170.0 | .148 | .016 | 465.905 | .003% | 99.997% |
| 175.0 | .178 | .012 | 465.917 | .003% | 99.999% |
| 180.0 | .119 | .004 | 465.920 | .001% | 100.000% |

Attachment B – EUT PHOTO



Attachment C – LM-80 Report Summary

| | |
|--|---|
| Report originated by | Bay Area Compliance Laboratories Corp. (Dongguan). |
| Manufactured by | Shenzhen Smalite Semiconductor Co.,Ltd |
| LM-80 report No. | R2DG140930050-10-10000 |
| LED Model | SL-IB2835FTA-31KAG |
| LED Part Number | SL-IB2835FTA-31KAG |
| Number of LED light source tested | 25 units |
| Drive Current | 100mA |

| Case temperature | 85°C | 105°C |
|--|-------------|--------------|
| 10000 hours lumen maintenance | 96.16% | 94.52% |
| 10000 hours color maintenance($\Delta u'v'$) | 0.0032 | 0.0029 |

Attachment D – TM-21 Report



TM-21 Report

| Table 1: Report at each LM-80 Test Condition | | | | | |
|--|----------------|--|----------------|--|---|
| Description of LED Light Source Tested (manufacturer, model, catalog number) | | SL-IB2835FTA-31KAG | | | |
| Test Condition 1 - 85° C Case Temp | | Test Condition 2 - 105° C Case Temp | | | |
| Sample size | 25 | Sample size | 25 | Sample size | - |
| Number of failures | 0 | Number of failures | 0 | Number of failures | - |
| DUT drive current used in the test (mA) | 100 | DUT drive current used in the test (mA) | 100 | DUT drive current used in the test (mA) | - |
| Test duration (hours) | 10,000 | Test duration (hours) | 10,000 | Test duration (hours) | - |
| Test duration used for projection (hour to hour) | 5,000 - 10,000 | Test duration used for projection (hour to hour) | 5,000 - 10,000 | Test duration used for projection (hour to hour) | - |
| Tested case temperature (° C) | 85 | Tested case temperature (° C) | 105 | Tested case temperature (° C) | - |
| α | 4.913E-06 | α | 6.195E-06 | α | - |
| B | 1.009 | B | 1.004 | B | - |
| Calculated L70(10k) (hours) | 74,000 | Calculated L70(10k) (hours) | 58,000 | Calculated L70(10k) (hours) | - |
| Reported L70(10k) (hours) | >60000 | Reported L70(10k) (hours) | 58,000 | Reported L70(10k) (hours) | - |

| Table 2: Interpolation Report (projection based on <i>in-situ</i> temperature entered) | |
|--|-----------|
| T _{s,1} (° C) | 85.00 |
| T _{s,1} (K) | 358.15 |
| α_1 | 4.913E-06 |
| B ₁ | 1.009 |
| T _{s,2} (° C) | - |
| T _{s,2} (K) | - |
| α_2 | - |
| B ₂ | - |
| E _a /k _b | - |
| A | - |
| B ₀ | 1.009 |
| T _{s,i} (° C) | 62.80 |
| T _{s,i} (K) | 335.95 |
| α_i | 4.913E-06 |
| Projected L70(10k) at | 74,000 |
| Reported L70(10k) at | >60000 |

----End of report----