# Energy Star Directional Luminaire Test Report

For

## Espen Technology, Inc

12257 FLORENCE AVE SANTA FE SPRINGS, CA 90670 USA

## Downlights

Model Name(s):
VEKR9.5D/8T/27W-10V

Representative (Tested) Model:
VEKR9.5D/8T/27W-10V

**Model Difference: Product is color tunable, can be tunable from 3000K, 3500K and 4000K.**

Prepare by:

Engineer: Alan Wang
Date: 2021-05-27

Review by:

Technical Lead: Vincent Yuan
Issue Date: 2021-06-02
Revised Date: N/A

Note:
1. The results contained in this report pertain only to the tested samples.
2. This report shall not be reproduced, no limited part or full, without approval of Dongguan New Testing Centre Co., Ltd
3. This report does not imply product certification, approval, or endorsement by NVLAP, or any agency of the Federal Government.

**Client Information:**

| | |
|---|---|
| Applicant Name: | Espen Technology, Inc |
| Brand Name: | Espen |
| Manufacturer Name: | Espen Technology, Inc |
| Manufacturer Address: | 12257 FLORENCE AVE SANTA FE SPRINGS, CA 90670 USA |

**Product Information:**

| | |
|---|---|
| Model Number: | VEKR9.5D/8T/27W-10V |
| Product Type: | Downlighs |
| Rating Input: | 120-277Vac, 50/60Hz, 17/21/27W |
| Declared CCT: | 3000K/3500K/4000K |
| Declared Lifetime: | 50000 hours |
| LED Manufacturer: | Lextar Electronics Corp. |
| LED Model: | PC35H13 |
| LED Quantity: | 104 pcs |
| Dimming Type: | Dimmable |

**Test Information:**

| | |
|---|---|
| Standard Lamp: | Total Spectral Radiant Flux Standard Lamp, trace to NIST.<br>1. D908S for Gonio<br>2. D215S for Integrating Sphere |
| Dimmer Manufacturer: | Lutron |
| Dimmer Model: | [X] NTSTV-DV [ ] DVCL-153P [ ] SCL-153P |
| Date of Receipt Samples: | 2021-05-26 |
| Quantity of Receipt Samples: | 3 pcs |
| Sample Number: | 210526003-S1~S3 |

**Laboratory Information:**

| | |
|---|---|
| Test Laboratory: | Dongguan New Testing Centre Co., Ltd |
| Laboratory Address: | 3F, No. 1 the 1st North Industry Road, Songshan Lake Science & Technology Park, Dongguan, Guangdong, China |
| Laboratory Contact Name: | Neil Zhong |
| Laboratory Contact E-mail: | Neil_zhong@ntc-cert.com |

**Report Information:**

| | |
|---|---|
| Issued Date of Test Report: | 2021-06-02 |
| Revised Date of Test Report: | N/A |
| Test Report No.: | NTCLR21050217 |
| Remark *(If applicable)*: | 1. The lowest CCT with the maximum wattage was tested, which is the default and most consumptive condition. |

## Photo of Sample

## Annex

| Regulatory Body | Test Method Regulation or Program Evaluated to | Tests to Determine Compliance | Test Limit Per Regulation or Program Requirement | Measured Efficiency or Limit Level | Pass or Fail |
|---|---|---|---|---|---|
| **9 PHOTOMETRIC PERFORMANCE REQUIREMENTS** | | | | | |
| Energy Star | ENERGY STAR ® Program Requirement Product Specification for Luminaire (Light Fixture) Eligibility Criteria Version V2.2 Section 9.2 | Luminaire Efficacy (Initial) | ≥ 55 lm/W | 129.31 lm/W | Pass |
| | | Luminaire Minimum Light Output (Initial) | ⩽ 4.5" aperture: 345 lumens<br>> 4.5" aperture: 575 lumens | 3450.1 lm | Pass |
| | | Luminaire Zonal Lumen Density | 75% of total lumens within the 0-60° zone | 89.2% | Pass |
| Energy Star | ENERGY STAR ® Program Requirement Product Specification for Luminaire (Light Fixture) Eligibility Criteria Version V2.2 Section 9.3 | Rated Correlated Color Temperature (CCT) | One of the following nominal correlated color temperatures (CCTs):<br>2700 Kelvin<br>3000 Kelvin<br>3500 Kelvin<br>4000 Kelvin<br>5000 Kelvin | 3000K<br>3500K<br>4000K | Pass |
| | | Measured Correlated Color Temperature (CCT) | One of the following targets correlated color temperatures (CCTs):<br>2725 ± 145 K<br>3045 ± 175 K<br>3465 ± 245 K<br>3985 ± 275 K<br>5028 ± 283 K | 3012K<br>(@ 120Vac) | Pass |
| Energy Star | ENERGY STAR ® Program Requirement Product Specification for Luminaire (Light Fixture) Eligibility Criteria Version V2.2 Section 9.4 | Color Rendering Index (CRI) | Ra ≥ 80 & R9 > 0 | Ra=82.5 & R9=5<br>(@ 120Vac) | Pass |
| Energy Star | ENERGY STAR ® Program Requirement Product Specification for Luminaire (Light Fixture) Eligibility Criteria Version V2.2 Section 9.5 | Color Angular Uniformity | The variation of chromaticity shall be within a total linear distance of 0.006 from the weighted average point on the CIE 1976 (u',v') diagram. | 0.0018 | Pass |

| 10 LUMEN MAINTENANCE AND RATED LIFE REQUIREMENTS | | | | | |
|---|---|---|---|---|---|
| Energy Star | ENERGY STAR ® Program Requirement Product Specification for Luminaire (Light Fixture) Eligibility Criteria Version V2.2 Section 10.1 | Lumen Maintenance | Shall meet the following L70 rated lumen maintenance life values, in situ: L70(6k) ≥ 25,000 hours for indoor L70(6k) ≥ 35,000 hours for outdoor L70 ≥ 50,000 hours for inseparable luminaires | > 60000 hours | Pass |
| Energy Star | ENERGY STAR ® Program Requirement Product Specification for Luminaire (Light Fixture) Eligibility Criteria Version V2.2 Section 10.1 | Maximum In-Situ Source Temperature | 1. In the sample luminaire, the in situ TMPLED temperature is less than or equal to the temperature specified in the LM-80 test report for the corresponding or higher drive current. 2. The drive current measured in the luminaire is less than or equal to the drive current specified in the LM-80 test report at the corresponding temperature or higher. | 60.3°C ≤ 85 °C 52.5 mA ≤ 100 mA (@ 120Vac) | Pass |
| Energy Star | ENERGY STAR ® Program Requirement Product Specification for Luminaire (Light Fixture) Eligibility Criteria Version V2.2 Section 10.2 | Light Source Life | Shall meet the following L70 lumen maintenance life vales: ≥ 25,000 hours for indoor luminaires ≥ 35,000 hours for outdoor luminaires ≥ 50,000 hours for inseparable luminaires | >60000hours | Pass |
| Energy Star | ENERGY STAR ® Program Requirement Product Specification for Luminaire (Light Fixture) Eligibility Criteria Version V2.2 Section 10.3 | Color Maintenance | For all LM-80 samples, at any measurement point, the distance of the chromaticity coordinates from the initial (zero-hour) chromaticity coordinates shall not exceed 0.007 at the temperature(s) adjacent to the measured in situ TMPLED temperature, and at the corresponding drive current. | LM-80 report has been verified and the chromaticity shift ( Δ u'v') is 0.0035 | Pass |

| 11 ELECTRICAL PERFORMANCE REQUIREMENTS | | | | | |
|---|---|---|---|---|---|
| Energy Star | ENERGY STAR ® Program Requirement Product Specification for Luminaire (Light Fixture) Eligibility Criteria Version V2.2 Section 11.1 | Source Star Time | Light Source shall remain continuously illuminated within 750 milliseconds of application of electrical power | 296.0 ms (@120 Vac) | Pass |
| Energy Star | ENERGY STAR ® Program Requirement Product Specification for Luminaire (Light Fixture) Eligibility Criteria Version V2.2 Section 11.3 | Power Factor | Total Luminaire input power ≤ 5 watts: PF ≥ 0.5 Total luminaire input power > 5 watts: PF ≥ 0.7 | 0.9881 (@120 Vac) | Pass |
| Energy Star | ENERGY STAR ® Program Requirement Product Specification for Luminaire (Light Fixture) Eligibility Criteria Version V2.2 Section 11.4 | Transient Protection | 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. | During and after test, the product operated normally | Pass |
| Energy Star | ENERGY STAR ® Program Requirement Product Specification for Luminaire (Light Fixture) Eligibility Criteria Version V2.2 Section 11.5 | Standby Power Consumption | Luminaire shall not draw power in the off state. | 0W | Pass |
| Energy Star | ENERGY STAR ® Program Requirement Product Specification for Luminaire (Light Fixture) Eligibility Criteria Version V2.2 Section 11.6 | Operating Frequency | ≥ 120 Hz | 120.0Hz (@ 120Vac) | Pass |
| Energy Star | ENERGY STAR ® Program Requirement Product Specification for Luminaire (Light Fixture) Eligibility Criteria Version V2.2 Section 11.6 | Flicker | $P_{st} \leq 1.0$ SVM ≤ 1.6 | $P_{st}$=0.263 SVM=0.988 | Pass |

| | | | | | |
|---|---|---|---|---|---|
| **12 LUMINAIRE SERVICEABILITY REQUIREMENTS** | | | | | |
| Energy Star | ENERGY STAR ® Program Requirement Product Specification for Luminaire (Light Fixture) Eligibility Criteria Version V2.2 Section 12.1 | Light Source Replaceability | LED light engines or retrofit kits shall make use of electrical interconnects that allow for consumer replacement of the engine or kit without the cutting of wires or the use of solder. Wire nuts and other reusable connectors are allowed. | Validated | Pass |
| Energy Star | ENERGY STAR ® Program Requirement Product Specification for Luminaire (Light Fixture) Eligibility Criteria Version V2.2 Section 12.2 | Ballast/Driver Replaceability | Ballast/Driver shall make use of electrical interconnects that allow for consumer replacement of the ballast/driver without the cutting of wires or the use of solder. Wire nuts and other reusable connectors are allowed. | Validated | Pass |
| **13 THERMAL PERFORMANCE REQUIREMENTS** | | | | | |
| Energy Star | ENERGY STAR ® Program Requirement Product Specification for Luminaire (Light Fixture) Eligibility Criteria Version V2.2 Section 13.1 | Maximum Measured Ballast or Driver Case Temperature | At the temperature measurement point for the hottest location on the driver case (TMPC as detailed by the driver manufacturer), the measured driver case temperature at thermal equilibrium shall not exceed the driver manufacturer's maximum recommended temperature during in situ (installed in the luminaire) operation. | 85.4°C< 105°C (@ 120Vac) | Pass |
| Energy Star | ENERGY STAR ® Program Requirement Product Specification for Luminaire (Light Fixture) Eligibility Criteria Version V2.2 Section 13.2 | Recessed Downlight Thermal Performance | Insulation contact (Type IC): Recessed downlights marketed as Type IC shall be approved for zero clearance insulation cover by an OSHA NRTL laboratory. | N/A | N/A |
| **14 SAFETY REQUIREMENTS** | | | | | |
| Energy Star | ENERGY STAR ® Program Requirement Product Specification for Luminaire (Light Fixture) Eligibility Criteria Version V2.2 Section 14.1 | Indoor Luminaire Safety | Demonstrate compliance with ANSI/UL 1574-2004, ANSI/UL 1598-2008, ANSI/UL 1598C-2014, ANSI/UL 2108-2004 or 2015, ANSI/UL 8750-2009 or 2015, as applicable. | Validated | Validated |
| Energy Star | ENERGY STAR ® Program Requirement Product Specification for Luminaire (Light Fixture) Eligibility Criteria Version V2.2 Section 14.2 | Electronic Ballast or Driver Safety | Demonstrate compliance with ANSI/UL 1310-2010, ANSI/UL 2108-2004 or 2015, ANSI/UL 8750-2009 or 2015, as applicable. | Validated | Validated |

| | | | | | |
|---|---|---|---|---|---|
| **15 CONTROL REQUIREMENTS** | | | | | |
| Energy Star | ENERGY STAR ® Program Requirement Product Specification for Luminaire (Light Fixture) Eligibility Criteria Version V2.2 Section 15.1 | Dimming | The luminaire and its components shall provide continuous dimming from 100% to 20% of light output. Luminaire shall not emit noise above 24dBA at 1 meter or less at the minimum output. | 15.8 dBA | Pass |
| Energy Star | ENERGY STAR ® Program Requirement Product Specification for Luminaire (Light Fixture) Eligibility Criteria Version V2.2 Section 15.2 | Products with Connected Functionality (Optional) | Product must continue to comply with the applicable product safety standards – the addition of the functionality shall not override existing safety protections and functions.<br>Must comply with section 11.5 Standby Power. | N/A | N/A |
| **16 PRODUCT LABELING & PACKAGING REQUIREMENTS** | | | | | |
| Energy Star | ENERGY STAR ® Program Requirement Product Specification for Luminaire (Light Fixture) Eligibility Criteria Version V2.2 Section 16.1 | Labeling & Packaging | Packaging and marketing claims shall represent the product consistent with its certification. | Validated | Pass |
| | | Labeling & Packaging | Packaging shall clearly describe the nominal color designation of the lamp in units of Kelvin (e.g. 2700K, 3000K) and may display recommended corresponding nomenclature as outlined below. This can also be met through use of a Lighting Facts label (as applicable).<br>2700 – Soft White<br>3000 – Warm White<br>3500 – Neutral White<br>4000/4100K – Cool White<br>5000K – Daylight | Validated | Pass |
| | | Labeling & Packaging | **For luminaires shipped with lamps containing mercury:**<br>Both the lamp and the luminaire packaging shall have a label indicating mercury content which must be managed and disposed of properly, and shall reference: www.epa.gov/cfl | N/A | N/A |
| | | Labeling & Packaging | **For outdoor luminaires:**<br>Packaging shall indicate the minimum (lowest) starting temperature for the lamp and ballast platform of the luminaire. | N/A | N/A |

| | | | | | |
|---|---|---|---|---|---|
| | | Labeling & Packaging | **For luminaires marketed as dimmable:** Luminaire packaging shall indicate dimming range (as applicable), a list or web site address with compatible dimmers or other controls, and known incompatibilities with dimmers, occupancy or vacancy sensors, timing devices or other external lighting controls, or a message noting limitations and web site address to find out more specific information. Step dimming capability, if employed, shall be clearly indicated. | Validate | Pass |
| | | Labeling & Packaging | **For recessed downlight luminaires that are insulation-contact (Type IC) rated**: Packaging shall clearly state this rating. Sample language: "IC-rated for direct contact with insulation". | N/A | N/A |
| | | Labeling & Packaging | **For recessed downlight luminaires that are airtight (AT) certified:** Packaging shall indicate that the luminaire permits air leakage less than 2.0 CFM at 75 Pascals when tested in accordance with ASTM E283-04. Sample language: "Certified airtight per ASTM E283-04." | N/A | N/A |
| Energy Star | ENERGY STAR ® Program Requirement Product Specification for Luminaire (Light Fixture) Eligibility Criteria Version V2.2 Section 16.2 | Light Source Shipment | Complete light source components shall be provided with the luminaire or retrofit kit. | Validated | Pass |
| | | Warranty | Integrated LED lamps shipped with the luminaire shall carry a minimum 3 year warranty. For luminaires incorporating non-replaceable drivers, the above warranty requirement is extended to 5 years. Warranty language shall place no limitations on coverage based on duration of luminaire operation (e.g. hours per day). | 5 years | Pass |

| Test Specification: | |
|---|---|
| Date of Test | 2021-05-26~2021-05-27 |
| Test Item | 1. Total Luminous Flux<br>2. Luminous Efficacy<br>3. Correlated Color Temperature<br>4. Color Rendering Index<br>5. Chromaticity Coordinate<br>6. Transient Protection<br>7. Source Start Time<br>8. Operation Frequency<br>9. Audible Noise<br>10. Flicker<br>11. In-Situ Temperature Measured Test<br>12. Maximum Measured Driver Case Temperature |
| Reference Standard | ENERGY STAR® Program Requirements for Luminaires<br>IES LM-79-2008 Electrical and Photometric Measurements of Solid-State Lighting Products<br>IES LM-84-14 IES Approved Method for Measuring Luminous Flux and Color Maintenance of LED Lamps, Light Engines, and Luminaires<br>ANSI C78.377-2017 Specifications for the Chromaticity of Solid State Lighting Products<br>CIE 13.3-1995 Method of Measuring and Specifying Color Rendering Properties of Light Sources<br>CIE 15-2004 Technical Report Colorimetry<br>NEMA-77-2017 Standard for Temporal Light Artifacts: Test Methods and Guidance for Acceptance Criteria<br>ANSI/IEEE C62.41 (Category A) Recommended Practice on Surge Voltages in Low – Voltage AC Circuits<br>ANSI/UL 1598-2018 Luminaire |

## Test Methods:

**1. Photometric and Electrical Measurements – Integrating Sphere Method:**

Photometric parameters were measured using an integrating sphere, as spectroradiometer and software. The ambient temperature condition inside the sphere was measured at 25 °C± 1°C. The sample measurements were made using a spectroradiometer connected by a fiber optic cable and detector through the detector port of the integrating sphere. The sample was operated at require Voltage and Frequency. It was stabilized before measurement was made. Chromaticity Coordinates, Correlated Color Temperature and Color Rendering Index were calculated from the spectral radiant flux measurements taken at least 1 nm intervals over the rage of 380 to 780 nm.

**2. Transient Protection Test**

The transient protection tests at ambient temperature were performed on one sample. The sample was operated at rated input voltage in the base - up orientation during the tests. Test system with an 100kHz Ring Wave Module and a Coupler/Decoupler Module was used to generate the 2500 volt ring wave transient strike across the lamp base contacts. Each wave consisted of a 0.5 microsecond rise time. Seven strikes were performed on each lamp sample in accordance with ANSI/IEEE C62.41 (Category A): Recommended Practice on Surge Voltages in Low – Voltage AC Circuits.

**3. Source Start Time**

Each test sample was operated in its designated orientation at rated input voltage in a 25 °C± 5°C ambient. The sample was operated at 120 Volts AC, 60 Hz. A photodetector is used to monitor the luminaire light output. Time shall be measured by a Flicker Photometer.

**4. Operation Frequency**

Each test sample was operated at rated input voltage. The sample was operated at 120 Volts AC, 60Hz.Light output waveform shall be measured by a Flicker Photometer.

**5. In-Situ Temperature Measurement Test (ISTMT)**

According to UL 1598 and IES LM-84-14, Annex A, maximum LED source operated temperature measurements were taken on one test sample per model with a thermocouple and temperature meter. The SSL sample could reach thermal equilibrium for at least 3 hours before measurements were taken. LED source temperature was measured at the point as indicated by the included diagram in accordance with manufacturers declared hot spot location. The maximum temperature was recorded for the sample. A simulated ceiling or other enclosure may be used in accordance to UL 1598 as applicable.

**6. Maximum Measured Ballasted or Driver Case Temperature**

Maximum driver case temperature measurement was taken on one test sample per model with a thermocouple and temperature meter. The SSL sample was allowed to reach thermal equilibrium for at least 3 hours before measurements were taken. Driver case temperature was measured at the point as indicated by the included diagram in accordance with manufacturers declared hot spot location. The maximum temperature was recorded for the sample. A simulated ceiling or other enclosure may be used in accordance to UL 1598 as applicable.

## Integrating Sphere Test Results:

### Test Condition:

| Test Ambient (°C) | Test Humidity (%) | Orientation | Stabilization Time (minute) | Test Time (minute) |
|---|---|---|---|---|
| 24.6 | 55.7 | Face Down | 90 | 10 |

### Electrical Data:

| CCT setting | Voltage (V) | Frequency (Hz) | Current (A) | Wattage (W) | Power Factor |
|---|---|---|---|---|---|
| 3000K | 120.0 | 60 | 0.2250 | 26.68 | 0.9881 |
| 3500K | 120.0 | 60 | 0.2184 | 25.88 | 0.9876 |
| 4000K | 120.0 | 60 | 0.2237 | 26.54 | 0.9887 |

### Color Data:

| CCT setting | CCT (K) | $R_a$ | $R_9$ | Chromaticity | | |
|---|---|---|---|---|---|---|
| | | | | (x, y) | (u', v') | Duv |
| 3000K | 3012 | 82.5 | 5 | (0.4332,0.3978) | (0.2509,0.5183) | -0.0020 |
| 3500K | 3415 | 83.6 | 9 | (0.4089,0.3899) | (0.2384,0.5115) | -0.0011 |
| 4000K | 3879 | 83.0 | 6 | (0.3872,0.3844) | (0.2265,0.5059) | 0.0016 |

### Specified Color Rending

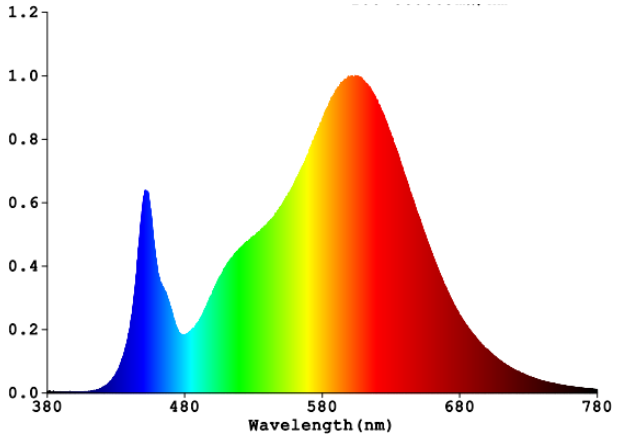
| CCT setting | R1 | R2 | R3 | R4 | R5 | R6 | R7 | R8 | R9 | R10 | R11 | R12 | R13 | R14 | R15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3000K | 81 | 92 | 95 | 80 | 82 | 90 | 81 | 58 | 5 | 82 | 80 | 72 | 84 | 98 | 74 |
| 3500K | 82 | 92 | 96 | 82 | 83 | 89 | 84 | 61 | 9 | 81 | 81 | 67 | 85 | 99 | 76 |
| 4000K | 81 | 90 | 96 | 82 | 81 | 86 | 86 | 63 | 6 | 76 | 81 | 61 | 83 | 98 | 74 |

### Output Data:

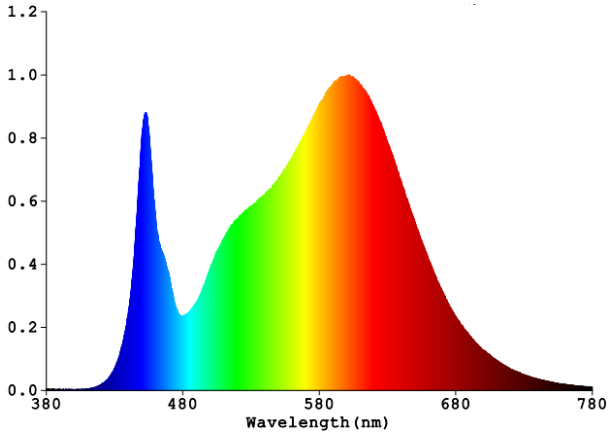
| CCT setting | Light output (lm) | Efficacy (lm/W) |
|---|---|---|
| 3000K | 3450.1 | 129.31 |
| 3500K | 3638.5 | 140.59 |
| 4000K | 3609.9 | 136.02 |

## Spectrum Diagram:

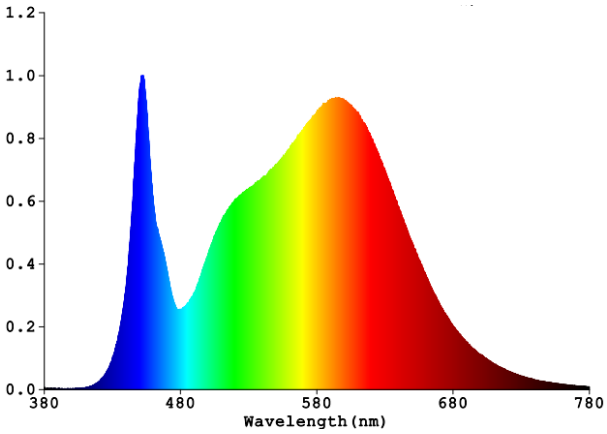
3000K




3500K




4000K




## Color Angular Uniformity

| Test Result | Maximum Δu'v' |
|---|---|
| | 0.0018 |

## Goniophotometer Test Results:

**Test Condition:**

| Test Ambient (°C) | Test Humidity (%) | Orientation | Stabilization Time (minute) | Test Time (minute) |
|---|---|---|---|---|
| 24.8 | 57.2 | Face Down | 90 | 25 |

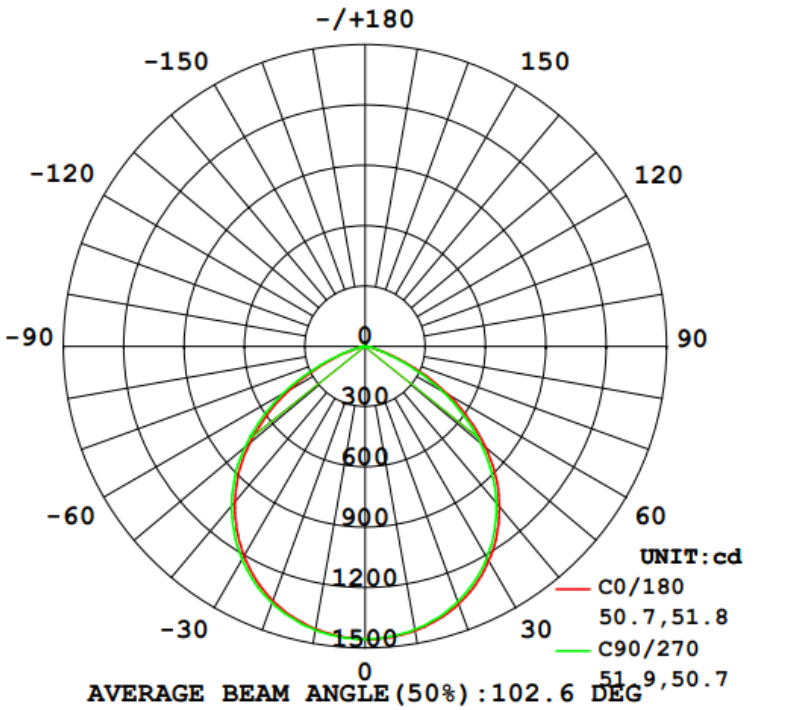
**Electrical Data:**

| Voltage (V) | Frequency (Hz) | Current (A) | Wattage (W) | Power Factor |
|---|---|---|---|---|
| 120.0 | 60 | 0.2250 | 26.68 | 0.9881 |

**Goniophotometer Data:**

| Parameter | Results |
|---|---|
| Total Luminous (lm) | 3450.1 |
| Luminous Efficacy (lm/w) | 129.31 |
| Zonal Lumens Distribution (0-60°) | 89.2% |
| Beam Angle (°) | 102.6 |
| Center Beam Candle Power (cd) | 1455 |

## Luminous Intensity Distribution Diagram:

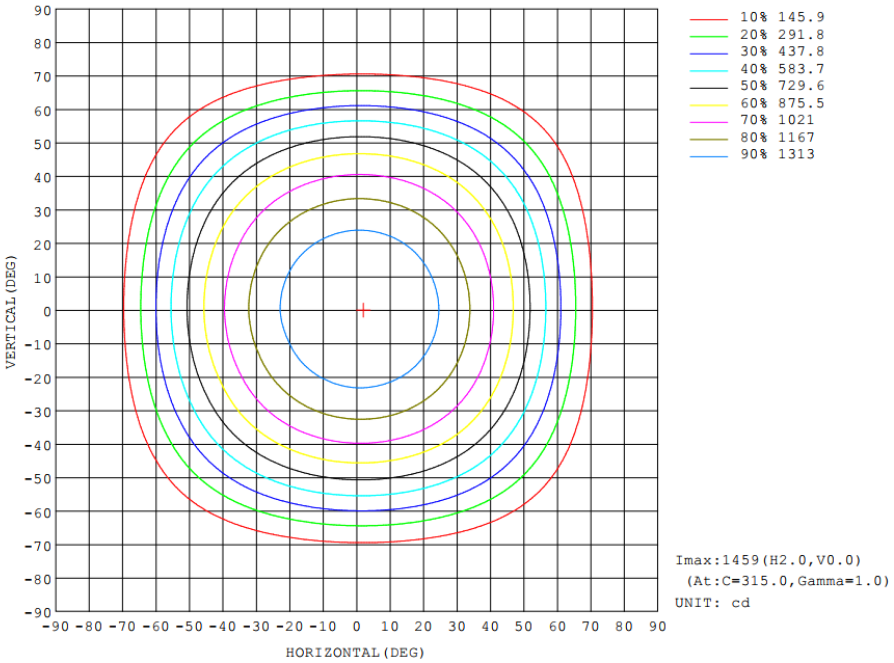


## Zonal Flux Diagram:

ZONAL FLUX DIAGRAM:

| γ | C0 | C45 | C90 | C135 | C180 | C225 | C270 | C315 | γ | Φ zone | Φ total | %lum,lamp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 1436 | 1432 | 1428 | 1427 | 1427 | 1428 | 1432 | 1436 | 0- 10 | 137.7 | 137.7 | 3.99,3.99 |
| 20 | 1363 | 1358 | 1350 | 1346 | 1346 | 1349 | 1358 | 1365 | 10- 20 | 394.8 | 532.6 | 15.4,15.4 |
| 30 | 1231 | 1224 | 1212 | 1205 | 1206 | 1211 | 1225 | 1233 | 20- 30 | 595.7 | 1128 | 32.7,32.7 |
| 40 | 1040 | 1030 | 1016 | 1006 | 1009 | 1018 | 1032 | 1045 | 30- 40 | 704.9 | 1833 | 53.1,53.1 |
| 50 | 781.9 | 770.4 | 750.8 | 740.4 | 750.5 | 766.1 | 782.8 | 795.5 | 40- 50 | 696.0 | 2529 | 73.3,73.3 |
| 60 | 470.2 | 455.6 | 435.8 | 426.1 | 438.3 | 454.7 | 473.2 | 484.7 | 50- 60 | 547.9 | 3077 | 89.2,89.2 |
| 70 | 156.8 | 144.8 | 132.0 | 127.2 | 136.9 | 146.6 | 159.6 | 167.7 | 60- 70 | 290.5 | 3368 | 97.6,97.6 |
| 80 | 26.47 | 25.11 | 23.41 | 22.52 | 23.66 | 25.02 | 26.71 | 27.83 | 70- 80 | 70.67 | 3438 | 99.7,99.7 |
| 90 | 0.0427 | 0.0232 | 0.0089 | 0.0051 | 0.0040 | 0.0035 | 0.1025 | 0.2887 | 80- 90 | 11.73 | 3450 | 100,100 |
| 100 | 0.0048 | 0.0048 | 0.0023 | 0.0047 | 0.0076 | 0.0060 | 0.0036 | 0.0052 | 90-100 | 0.0105 | 3450 | 100,100 |
| 110 | 0.0122 | 0.0113 | 0.0160 | 0.0138 | 0.0135 | 0.0144 | 0.0133 | 0.0110 | 100-110 | 0.0086 | 3450 | 100,100 |
| 120 | 0.0203 | 0.0210 | 0.0189 | 0.0285 | 0.0168 | 0.0168 | 0.0105 | 0.0154 | 110-120 | 0.0152 | 3450 | 100,100 |
| 130 | 0.0300 | 0.0329 | 0.0305 | 0.0394 | 0.0310 | 0.0268 | 0.0270 | 0.0324 | 120-130 | 0.0221 | 3450 | 100,100 |
| 140 | 0.0393 | 0.0410 | 0.0322 | 0.0394 | 0.0437 | 0.0456 | 0.0398 | 0.0556 | 130-140 | 0.0284 | 3450 | 100,100 |
| 150 | 0.0484 | 0.0516 | 0.0453 | 0.0504 | 0.0628 | 0.0707 | 0.0568 | 0.0789 | 140-150 | 0.0307 | 3450 | 100,100 |
| 160 | 0.0556 | 0.0612 | 0.0598 | 0.0617 | 0.0940 | 0.1122 | 0.0921 | 0.1080 | 150-160 | 0.0313 | 3450 | 100,100 |
| 170 | 0.0603 | 0.0506 | 0.0549 | 0.0569 | 0.1072 | 0.1165 | 0.1126 | 0.1205 | 160-170 | 0.0235 | 3450 | 100,100 |
| 180 | 0.0890 | 0.0365 | 0.0575 | 0.0440 | 0.0792 | 0.0764 | 0.0726 | 0.0728 | 170-180 | 0.0072 | 3450 | 100,100 |
| DEG | LUMINOUS INTENSITY:cd | | | | | | | | | UNIT:lm | | |

## Isocandela Diagram:



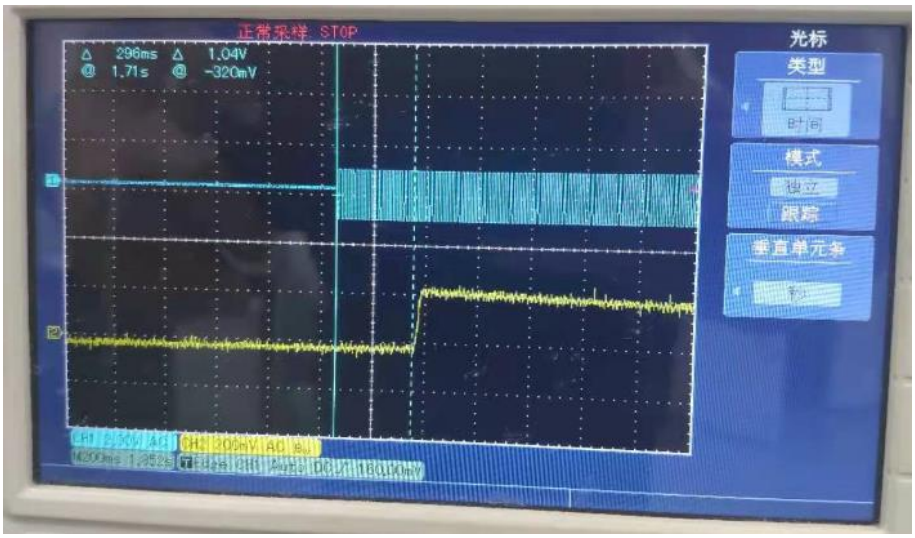
## Luminous Distribution Intensity Data:

Table--1 UNIT: cd

| γ (DEG) \ C(DEG) | 0 | 22.5 | 45 | 67.5 | 90 | 112.5 | 135 | 157.5 | 180 | 202.5 | 225 | 247.5 | 270 | 292.5 | 315 | 337.5 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1455 | 1455 | 1455 | 1455 | 1455 | 1455 | 1455 | 1455 | 1455 | 1455 | 1455 | 1455 | 1455 | 1455 | 1455 | 1455 | | | |
| 5 | 1452 | 1451 | 1449 | 1450 | 1449 | 1447 | 1449 | 1447 | 1446 | 1449 | 1448 | 1449 | 1451 | 1450 | 1452 | 1451 | | | |
| 10 | 1436 | 1435 | 1432 | 1432 | 1428 | 1427 | 1427 | 1425 | 1427 | 1427 | 1428 | 1431 | 1432 | 1433 | 1436 | 1436 | | | |
| 15 | 1406 | 1405 | 1403 | 1401 | 1398 | 1392 | 1392 | 1391 | 1393 | 1395 | 1395 | 1399 | 1401 | 1403 | 1408 | 1407 | | | |
| 20 | 1363 | 1361 | 1358 | 1355 | 1350 | 1345 | 1346 | 1342 | 1346 | 1347 | 1349 | 1354 | 1358 | 1360 | 1365 | 1365 | | | |
| 25 | 1305 | 1302 | 1299 | 1294 | 1289 | 1284 | 1283 | 1280 | 1282 | 1285 | 1288 | 1294 | 1298 | 1303 | 1308 | 1308 | | | |
| 30 | 1231 | 1228 | 1224 | 1219 | 1212 | 1206 | 1205 | 1201 | 1206 | 1208 | 1211 | 1218 | 1225 | 1229 | 1233 | 1234 | | | |
| 35 | 1142 | 1139 | 1135 | 1130 | 1122 | 1114 | 1113 | 1109 | 1113 | 1117 | 1122 | 1130 | 1135 | 1140 | 1147 | 1146 | | | |
| 40 | 1040 | 1036 | 1030 | 1024 | 1016 | 1009 | 1006 | 1003 | 1009 | 1012 | 1018 | 1026 | 1032 | 1038 | 1045 | 1045 | | | |
| 45 | 921 | 916 | 911 | 903 | 893 | 885 | 883 | 879 | 892 | 898 | 905 | 911 | 918 | 924 | 931 | 932 | | | |
| 50 | 782 | 778 | 770 | 761 | 751 | 742 | 740 | 738 | 750 | 757 | 766 | 776 | 783 | 789 | 796 | 796 | | | |
| 55 | 630 | 626 | 617 | 608 | 597 | 590 | 587 | 585 | 598 | 606 | 614 | 625 | 633 | 639 | 645 | 644 | | | |
| 60 | 470 | 464 | 456 | 447 | 436 | 428 | 426 | 425 | 438 | 446 | 455 | 465 | 473 | 480 | 485 | 484 | | | |
| 65 | 306 | 300 | 291 | 282 | 273 | 267 | 265 | 265 | 278 | 284 | 292 | 302 | 310 | 316 | 320 | 320 | | | |
| 70 | 157 | 152 | 145 | 138 | 132 | 128 | 127 | 127 | 137 | 141 | 147 | 153 | 160 | 165 | 168 | 168 | | | |
| 75 | 61.1 | 59.1 | 56.3 | 53.8 | 51.4 | 49.9 | 49.2 | 49.2 | 52.7 | 54.6 | 56.9 | 59.4 | 62.0 | 64.2 | 65.7 | 65.7 | | | |
| 80 | 26.5 | 25.9 | 25.1 | 24.2 | 23.4 | 22.8 | 22.5 | 22.5 | 23.7 | 24.2 | 25.0 | 25.9 | 26.7 | 27.4 | 27.8 | 27.9 | | | |
| 85 | 10.9 | 10.5 | 9.97 | 9.38 | 8.79 | 8.37 | 8.16 | 8.12 | 9.15 | 9.54 | 10.0 | 10.7 | 11.2 | 11.7 | 12.0 | 12.0 | | | |
| 90 | 0.04 | 1.12 | 0.02 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.10 | 0.17 | 0.29 | 0.30 | | | |
| 95 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | |
| 100 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | | | |
| 105 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.00 | 0.01 | 0.00 | 0.01 | 0.01 | | | |
| 110 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | | | |
| 115 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | | | |
| 120 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.03 | 0.03 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | | | |
| 125 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 | 0.03 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | | | |
| 130 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.04 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | | | |
| 135 | 0.03 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.03 | 0.03 | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | | | |
| 140 | 0.04 | 0.04 | 0.04 | 0.04 | 0.03 | 0.03 | 0.04 | 0.04 | 0.04 | 0.04 | 0.05 | 0.04 | 0.04 | 0.05 | 0.06 | 0.05 | | | |
| 145 | 0.04 | 0.05 | 0.05 | 0.04 | 0.04 | 0.04 | 0.05 | 0.05 | 0.05 | 0.05 | 0.06 | 0.06 | 0.05 | 0.05 | 0.07 | 0.06 | | | |
| 150 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.06 | 0.07 | 0.07 | 0.07 | 0.06 | 0.07 | 0.08 | 0.07 | | | |
| 155 | 0.05 | 0.05 | 0.06 | 0.05 | 0.05 | 0.05 | 0.06 | 0.05 | 0.08 | 0.08 | 0.09 | 0.08 | 0.08 | 0.08 | 0.09 | 0.08 | | | |
| 160 | 0.06 | 0.06 | 0.06 | 0.05 | 0.06 | 0.06 | 0.06 | 0.06 | 0.09 | 0.10 | 0.11 | 0.09 | 0.09 | 0.10 | 0.11 | 0.10 | | | |
| 165 | 0.06 | 0.06 | 0.06 | 0.05 | 0.06 | 0.06 | 0.06 | 0.05 | 0.10 | 0.11 | 0.12 | 0.11 | 0.11 | 0.11 | 0.12 | 0.11 | | | |
| 170 | 0.06 | 0.06 | 0.05 | 0.06 | 0.05 | 0.06 | 0.06 | 0.05 | 0.11 | 0.11 | 0.12 | 0.11 | 0.11 | 0.12 | 0.12 | 0.11 | | | |
| 175 | 0.05 | 0.04 | 0.04 | 0.05 | 0.04 | 0.04 | 0.04 | 0.04 | 0.09 | 0.10 | 0.10 | 0.10 | 0.09 | 0.09 | 0.10 | 0.09 | | | |
| 180 | 0.09 | 0.04 | 0.04 | 0.06 | 0.06 | 0.05 | 0.04 | 0.05 | 0.08 | 0.08 | 0.08 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | | | |

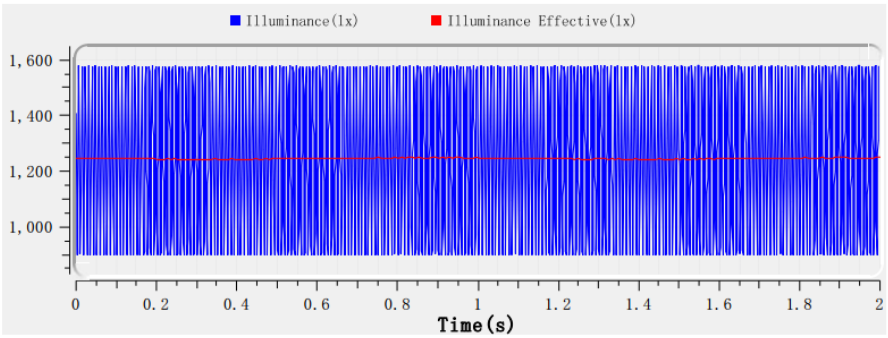
## Source Start Time:

| Test Result | Start Time (ms) |
|---|---|
| | 296.0 |

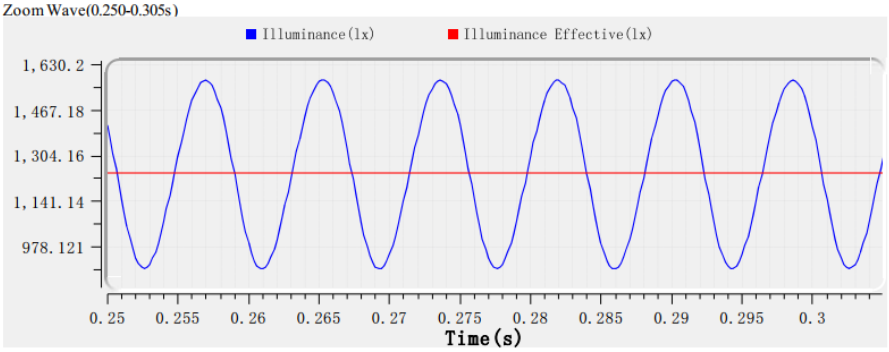



## Operating Frequency Test:

| Test Result | Operating Frequency (Hz) |
|---|---|
| | 120.0 |




Zoom Wave(0.250-0.305s)




### Test Result

| | | | | | |
|---|---|---|---|---|---|
| **Max(lx):** | 1.578 k | **Avg(lx):** | 1.230 k | **Min(lx):** | 898.2 |
| **Flicker Index:** | 0.087 | **Percent Flicker:** | 0.000% | **Frequency:** | 120.000 Hz |

## Power Factor Test:

| Test Result | Power Factor |
|---|---|
| | 0.9881 |

## Standby Power Consumption:

| Test Result | Power Consumption (W) |
|---|---|
| | 0 |

## Transient Protection Test:

| Test Result | After Test |
|---|---|
| | Work Normal |

## Flicker:

**Test Condition:**

| Parameter | Voltage (Vac) | Frequency (Hz) | Sampling Time (s) | Sampling Rate (kHz) |
|---|---|---|---|---|
| $P_{st}$ | 120 | 60 | 180 | 10 |
| SVM | 120 | 60 | 1 | 20 |

**Test result:**

| Parameter | Result | | |
|---|---|---|---|
| | Maximum Dimming Level | 50% Dimming Level | Minimum Dimming Level |
| $P_{st}$ | 0.100 | 0.263 | 0.233 |
| SVM | 0.988 | 0.952 | 0.145 |

## Dimming Test:

**Test Result:**

| Test Result | 100% Light Output (lm) | Min. Light Output (lm) | Dimming Level |
|---|---|---|---|
| | 3450.1 | 321.5 | 9.32% |

## In-Situ Temperature Measurement Test Results:

### Electrical Data:

| Voltage (V) | Frequency (Hz) | Current (A) | Wattage (W) | Power Factor | Orientation | Test Time (hours) |
|---|---|---|---|---|---|---|
| 120.0 | 60 | 0.2250 | 26.68 | 0.9811 | Face Down | 3.5 |

### Test Result:

| TC Location | Measured LED Drive Current (mA) | Temperature (°C) | | | Limits (°C) | TM-21 Result |
|---|---|---|---|---|---|---|
| | | Ambient | Test Result | Corrected to 25°C | | Reported L70 (hours) |
| $TMP_{LED}$ | 52.5 | 25.1 | 60.4 | 60.3 | 85 | >60000 |

### Test Result from TM-21:

**TM-21 Inputs**

**Instructions**

Yellow fields are completed by the user. Fields not used should be left blank. Cyan fields are calculated based on user entries.

First, enter a description of the LED light source tested. Then complete the fields labeled "LM-80 Testing Details". Test duration must be at least 6,000 hours. If only one case temperature data set is to be used (no interpolation), complete only "Tested case temperature 1". For only two case temperature data sets, complete 1 and 2.

Next, further to the right, in the corresponding box(es) for each tested case temperature, enter the test data along with the time (in hours) at which each measurement was taken. Data entered must be normalized then averaged measured data (per TM-21 sections 5.2.1 and 5.2.2). If case temperatures have different test durations, enter data up to the lowest of the test durations for all of the case temperatures.

Enter drive current, *in-situ* temperature data and the percentage of initial lumens to project to in the fields labeled "*In-Situ* Inputs".

Results can be tailored to estimate lumen maintenance at a specific time by entering a value (t) in the yellow field. A complete TM-21 report will appear on the next tab labeled "Report".

| Description of LED Light Source Tested (manufacturer, model, catalog number) |
|---|
| Lextar Electronics Corp.<br>PC35H13 |

| LM-80 Testing Details | |
|---|---|
| Total number of units tested per case temperature: | 25 |
| Number of failures: | 0 |
| Number of units measured: | 25 |
| Test duration (hours): | 10000 |
| Tested drive current (mA): | 100 |
| Tested case temperature 1 ($T_c$, °C): | 85 |
| Tested case temperature 2 ($T_c$, °C): | 105 |
| Tested case temperature 3 ($T_c$, °C): | |

***In-Situ* Inputs**

| | |
|---|---|
| Drive current for each LED package/array/module (mA): | 52.5 |
| *In-situ* case temperature ($T_c$, °C): | 60.3 |
| Percentage of initial lumens to project to (e.g. for $L_{70}$, enter 70): | 70 |

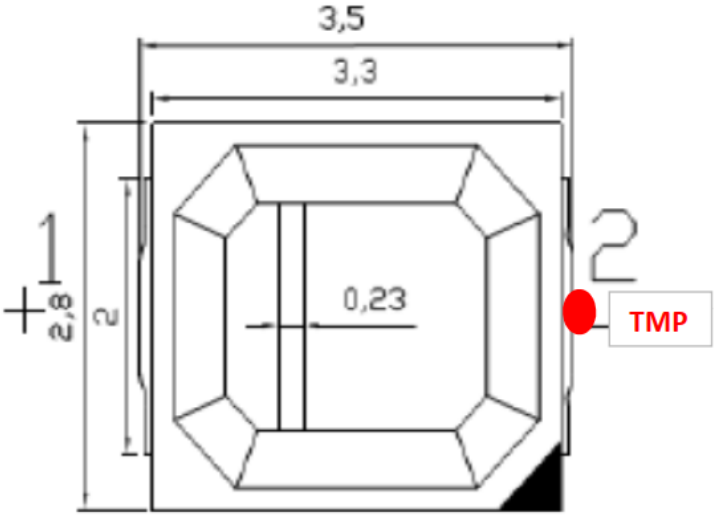
**Results**

| | |
|---|---|
| Time (t) at which to estimate lumen maintenance (hours): | 50,000 |
| Lumen maintenance at time (t) (%): | 78.94% |
| Reported L70 (hours): | >60000 |

**LM-80 Test Inputs**

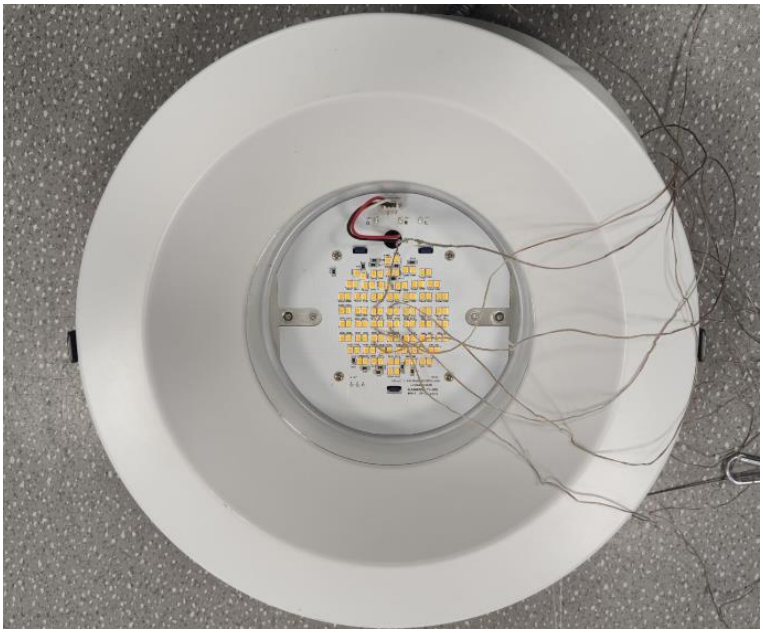
| Test Data for 85°C Case Temperature | | Test Data for 105°C Case Temperature | | Tested Case Temperature 3 | |
|---|---|---|---|---|---|
| Time (hours) | Lumen Maintenance (%) | Time (hours) | Lumen Maintenance (%) | Time (hours) | Lumen Maintenance (%) |
| 0 | 100.00% | 0 | 100.00% | | |
| 1000 | 100.94% | 1000 | 100.92% | | |
| 2000 | 100.44% | 2000 | 100.02% | | |
| 3000 | 99.97% | 3000 | 99.26% | | |
| 4000 | 99.35% | 4000 | 98.47% | | |
| 5000 | 98.60% | 5000 | 97.49% | | |
| 6000 | 97.98% | 6000 | 96.73% | | |
| 7000 | 97.35% | 7000 | 95.88% | | |
| 8000 | 96.92% | 8000 | 95.31% | | |
| 9000 | 96.61% | 9000 | 95.02% | | |
| 10000 | 96.16% | 10000 | 94.45% | | |

**TMP Position in LM-80:**




Temperature Measurement Point

**Thermocouple Position on TMP:**



## Maximum Measured Driver Case Temperatue Test Results:

**Electrical Data:**

| Voltage (V) | Frequency (Hz) | Current (A) | Wattage (W) | Power Factor | Orientation | Test Time (hours) |
|---|---|---|---|---|---|---|
| 120.0 | 60 | 0.2250 | 26.68 | 0.9811 | Face Down | 3.5 |

**Test Result:**

| TC Location | Temperature (°C) | | | Limits (°C) |
|---|---|---|---|---|
| | Ambient | Test Result | Corrected to 25 °C | |
| $TMP_{Driver}$ | 25.1 | 85.5 | 85.4 | 105 |

## Thermocouple Position on TMP

**Annex:**

| Data Comparison for different Wattage&CCT Setting | | | | | |
|---|---|---|---|---|---|
| Wattage &CCT Setting | Voltage (V) | Frequency (Hz) | Wattage (W) | Total Luminous (lm) | Luminous Efficacy (lm/w) |
| 17W 3000K | 120.0 | 60 | 16.98 | 2254.6 | 132.78 |
| 17W 3500K | 120.0 | 60 | 16.56 | 2341.2 | 141.38 |
| 17W 4000K | 120.0 | 60 | 16.86 | 2361.0 | 140.04 |
| 21W 3000K | 120.0 | 60 | 20.95 | 2806.1 | 133.94 |
| 21W 3500K | 120.0 | 60 | 20.32 | 2920.2 | 143.71 |
| 21W 4000K | 120.0 | 60 | 20.73 | 2918.0 | 140.76 |
| 27W 3000K | 120.0 | 60 | 26.68 | 3450.1 | 129.31 |
| 27W 3500K | 120.0 | 60 | 25.88 | 3638.5 | 140.59 |
| 27W 4000K | 120.0 | 60 | 26.54 | 3609.9 | 136.02 |

## Equipment List:

| Equipment ID | Equipment Name | Last Cal. | Due Cal. |
|---|---|---|---|
| NTC-F01-006 | 2.0 meter Integrating Sphere | 2020-11-12 | 2021-11-11 |
| NTC-F01-013 | Standard Lamp | 2020-11-12 | 2021-11-11 |
| NTC-F01-031 | Digital Power Meter | 2020-08-22 | 2021-08-21 |
| NTC-F01-019 | Temperature & Humidity Meter | 2020-11-13 | 2021-11-12 |
| NTCD-S049 | Digital Phosphor Oscilloscope | 2020-11-12 | 2021-11-11 |
| NTCD-S001 | Temperature Data Logger | 2020-11-12 | 2021-11-11 |
| NTC-F01-047 | Flicker Meter | 2020-11-12 | 2021-11-11 |
| NTC-F01-032 | Surge Meter | 2020-12-15 | 2021-12-14 |

************End of Report************