# TEST REPORT

According to ANSI/IES LM-80-15
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-3014H416W-S1-08HL-HR3

| | |
|---|---|
| **Report Type:**<br>10000 Hours Test Report | **Product Type:**<br>LED Package |
| **Reviewed By:** | Pote Wang |
| **Report Number:** | SZ2220725-33706E-EE-10000 |
| **Test Date:** | 2022-07-29 to 2023-10-20 |
| **Report Date:** | 2023-10-31 |
| **Approved by:** | Blake Zhang / EE Engineer |
| **Prepared By:** | Bay Area Compliance Laboratories Corp. (Dongguan).<br>No.12, Pulong East 1st Road, Tangxia Town, Dongguan, Guangdong, China.<br>Tel: +86-0769-86858888<br>Fax:+86-0769-86858588 |

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# 1 - General Information

## 1.1 Description of LED Light Sources#

### Sample Size:

50 PCS test samples were in good condition and received on 2022-07-25. The samples were numbered from 1 to 25 and 26 to 50.

| | |
|---|---|
| Manufacturer: | Hongli Zhihui Group Co.,Ltd. Guangzhou Branch |
| Part Number: | HL-A-3014H416W-S1-08HL-HR3 |
| Part Type: | LED Package |
| Drive Level: | DC 30mA |
| Nominal CCT: | 2700K |
| Power: | 0.102W |
| Average Current Density per LED die: | 387.5mA/$mm^2$ |
| Average Power Density per LED die: | 1.318W/$mm^2$ |
| CRI: | 80 |
| Die Spacing: | N/A |

### 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.

### Family products covered by this report:

According to *ENERGY STAR® Requirements for the Use of LM-80 Data*, the following products can be covered by this report base on the information and declaration provided by manufacturer. The information of these models shows that the covered products meet all section 4 requirements of *ENERGY STAR® Requirements for the Use of LM-80 Data* (September 28, 2017)

This report covers the following models:

| Model Type | Model Name | CRI (typ.) | Total Input Current (mA) | Power (W) | CCT (K) | Number of dies | Driver current per die (mA) | Current Density per Die ( $mA/mm^2$) | Power Density per PCB ($W/mm^2$) | Die Spacing (mm) |
|---|---|---|---|---|---|---|---|---|---|---|
| Test model | HL-A-3014H416W-S1-08HL-HR3 | 80 | 30 | 0.102 | 2700 | 1 | 30 | 387.5 | 0.0476 | / |
| Multiple model | HL-A-3014H***W-S1-08**-HR*-*** | 70-80 | 30 | 0.102 | 2700-6500 | 1 | 30 | 387.5 | 0.0476 | / |
| | HL-A-3014H***W-S1-08**-HR*(R9)-*** | 70-80 | 30 | 0.102 | 2700-6500 | 1 | 30 | 387.5 | 0.0476 | / |
| | HL-A-3014D***W-S1-08**-HR*-*** | 70-80 | 30 | 0.102 | 2700-6500 | 1 | 30 | 387.5 | 0.0476 | / |
| | HL-A-3014D***W-S1-08**-HR*(R9)-*** | 70-80 | 30 | 0.102 | 2700-6500 | 1 | 30 | 387.5 | 0.0476 | / |

Note: The model name begins with "HL", such as “HL-A-3014H***W-S1-08**-HR*-***”, " *" is described in detail as follows:
1 - The first “***” is the number from 1 to 999 which stands for the brightness level.
2 - The second “**” is the letter HL or None which stands for the bonding wire style.
3 - The third “*” is the number 1 or 2 or 3 which stands for the CRI style
4 - The fourth “***” is the letter which stands for the customer code.

## 1.2 Standards and Reference Documentations

- ANSI/IES LM-80-15: IES Approved Method for Measuring Lumen Maintenance of LED Light Sources.
- CIE 127:2007: Measurement of LEDs
- ENERGY STAR® Requirements for the Use of LM-80 Data (This standard was not accredited by IAS)

## 1.3 Testing Equipment

| Device | Manufacture | Model No | Serial No | Calibration date | Calibration due date |
|---|---|---|---|---|---|
| 0.5m integrating sphere | EVERFINE | AIS-2 | G185304TA1381172 | 2022-11-18 | 2023-11-17 |
| LED Test Source | EVERFINE | LTS-300 | P185616CD1371113 | 2022-11-18 | 2023-11-17 |
| High Accuracy Array Spectroradiometer | EVERFINE | HAAS-2000 | P600674CM1381123 | 2022-11-18 | 2023-11-17 |
| Standard Light Source | EVERFINE | D062 | M133799CM1381112 | 2023-05-12 | 2025-05-11 |
| Multilayer aging machine | BACL | B2-270 | 20015 | 2022-11-18 | 2023-11-17 |
| Program-controlled D.C. Stabilized Voltage Supply | Hanshenpuyuan | HSPY-200-01 | N/A | 2022-11-18 | 2023-11-17 |

## 1.4 Drive Level

Samples are driven with a constant direct current (DC) during maintenance test, photometric and electrical measurement. The current value was regulated to within ±3% of the specified value of the manufacturer during maintenance test, and was within ±0.5% during photometric and electrical measurement test.

## 1.5 Ambient Conditions for Maintenance Test

For lumen maintenance test, samples within one data set, were installed on cooling boards in thermal chambers with minimal ambient airflow. The case temperature and ambient temperature was monitored by thermocouples which one was soldered to the coldest DUTs' case ($TMP_{LED}$) location, while the other is mounted at a distance of 5 mm above the TMP location.

During life testing, $TMP_{LED}$ of the coldest LEDs were maintained at a temperature that was greater than or equal to 2°C below the corresponding nominal case temperature. Surrounding air was maintained at a temperature that was greater than or equal to 5°C below the corresponding nominal case temperature. Thermocouples were shielded from direct DUT optical radiation and comply with ASTM E230 Table 1 "Special Limits".

Samples were connected to DC power supply in series circuits with a constant current. The forward current was regulated to within ±3% of the specified value of the manufacturer.

The relative humidity within chamber was kept less than 65% during test.

For photometry measurement, the ambient temperature during test was set to 25°C ± 2°C, RH <65%.

## 1.6 Photometric Measurement Method and Uncertainty

Integrating sphere and spectroradiometer is used to measure luminous flux and chromaticity coordinate u'v'. 2π measurement was used and sample was drived by DC power supply. The forward current was regulated to within ±0.5% of the nominal value. The test system was calibrated by halogen reference lamp. The ambient temperature during test was set to 25°C ± 2°C, RH <65%. The temperature measurement point was located in the sphere and the temperature was detected by a temperature probe.

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=21K (K=2), at the 95% confidence level.

The uncertainty of the temperature is U=0.8671°C (K=2), at the 95% confidence level.

## 1.7 Statement of Traceability

Bay Area Compliance Laboratories Corp. (Dongguan) attested that all calibration has been performed using suitable standards traceable to National Primary Standards and International System of Units (SI).

## 1.8 Sample Set

**Data Set 1: 55°C, 30mA**

| | |
|---|---|
| Part Number: | HL-A-3014H416W-S1-08HL-HR3 |
| Number of Units: | 25 |
| Case Temperature: | >53°C |
| Ambient Temperature: | >50°C |
| Life Test Drive Current: | 30mA |
| Measurement Current: | 30mA |

**Data Set 2: 85°C, 30mA**

| | |
|---|---|
| Part Number: | HL-A-3014H416W-S1-08HL-HR3 |
| Number of Units: | 25 |
| Case Temperature: | >83°C |
| Ambient Temperature: | >80°C |
| Life Test Drive Current: | 30mA |
| Measurement Current: | 30mA |

## 2 - Summary of Test Result

| Data Set: | Sample Size | Failures Observed: | Test Interval | Test Duration | α | β | Reported TM-21 $L_{70}$ Lifetime |
|---|---|---|---|---|---|---|---|
| 1 | 25 | 0 | 1000hrs | 10000hrs | 2.100E-06 | 1.005 | >60000 hours |
| 2 | 25 | 0 | 1000hrs | 10000hrs | 2.559E-06 | 1.006 | >60000 hours |

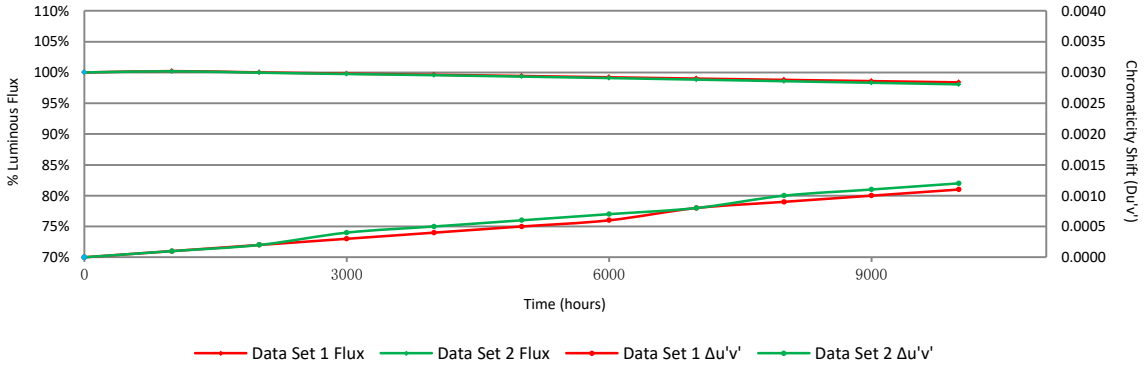
Average Lumen Maintenance (Percentage of Initial Luminous Flux)

| Data Set: | **1000hrs | **2000hrs | **3000hrs | **4000hrs | **5000hrs | **6000hrs | 7000hrs | 8000hrs | 9000hrs | 10000hrs |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 100.22% | 100.01% | 99.81% | 99.63% | 99.43% | 99.22% | 99.01% | 98.80% | 98.60% | 98.39% |
| 2 | 100.19% | 99.96% | 99.75% | 99.56% | 99.33% | 99.09% | 98.84% | 98.58% | 98.33% | 98.07% |

Average Chromaticity Shift

| Data Set: | **1000hrs | **2000hrs | **3000hrs | **4000hrs | **5000hrs | **6000hrs | 7000hrs | 8000hrs | 9000hrs | 10000hrs |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0001 | 0.0002 | 0.0003 | 0.0004 | 0.0005 | 0.0006 | 0.0008 | 0.0009 | 0.0010 | 0.0011 |
| 2 | 0.0001 | 0.0002 | 0.0004 | 0.0005 | 0.0006 | 0.0007 | 0.0008 | 0.0010 | 0.0011 | 0.0012 |

Average Lumen Maintenance and Chromaticity Shift VS. Time




**: The items tested by Bay Area Compliance Laboratories Corp. (Shenzhen) and covered by NVLAP accreditation, the reference report No. is SZ2220725-33706E-EE-6000 (test Date: 2022-07-29 to 2023-04-05).

Bay Area Compliance Laboratories Corp. (Shenzhen) is EPA-Recognized Laboratories and the ORG ID: 1105318

## 3 - Test Data

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

| No. | Φ(lm) | Lumen Maintenance (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **0hr(Initial) | **1000hrs | **2000hrs | **3000hrs | **4000hrs | **5000hrs | **6000hrs | 7000hrs | 8000hrs | 9000hrs | 10000hrs |
| 1 | 11.88 | 100.25 | 100.17 | 100.08 | 99.92 | 99.75 | 99.49 | 99.33 | 99.07 | 98.82 | 98.57 |
| 2 | 11.74 | 100.26 | 100.09 | 99.91 | 99.83 | 99.66 | 99.49 | 99.32 | 99.15 | 98.98 | 98.81 |
| 3 | 11.83 | 100.25 | 99.92 | 99.75 | 99.66 | 99.58 | 99.41 | 99.24 | 98.99 | 98.73 | 98.56 |
| 4 | 11.17 | 100.27 | 100.18 | 99.91 | 99.73 | 99.55 | 99.37 | 99.10 | 98.93 | 98.75 | 98.57 |
| 5 | 11.71 | 100.26 | 100.09 | 99.91 | 99.66 | 99.32 | 99.15 | 98.98 | 98.72 | 98.46 | 98.29 |
| 6 | 11.66 | 100.26 | 100.09 | 99.91 | 99.74 | 99.57 | 99.31 | 99.14 | 98.97 | 98.71 | 98.46 |
| 7 | 11.80 | 100.17 | 99.92 | 99.75 | 99.58 | 99.41 | 99.24 | 98.98 | 98.81 | 98.73 | 98.47 |
| 8 | 11.24 | 100.27 | 100.09 | 99.91 | 99.73 | 99.47 | 99.29 | 99.02 | 98.84 | 98.67 | 98.49 |
| 9 | 11.89 | 100.08 | 99.83 | 99.58 | 99.33 | 99.07 | 98.82 | 98.57 | 98.40 | 98.23 | 98.07 |
| 10 | 11.63 | 100.26 | 100.09 | 99.91 | 99.66 | 99.40 | 99.23 | 98.97 | 98.80 | 98.62 | 98.37 |
| 11 | 11.77 | 100.25 | 99.92 | 99.66 | 99.58 | 99.41 | 99.24 | 98.98 | 98.73 | 98.47 | 98.30 |
| 12 | 11.68 | 100.09 | 99.83 | 99.57 | 99.40 | 99.06 | 98.89 | 98.72 | 98.54 | 98.37 | 98.20 |
| 13 | 11.56 | 100.17 | 99.91 | 99.74 | 99.57 | 99.39 | 99.22 | 98.96 | 98.70 | 98.44 | 98.18 |
| 14 | 11.60 | 100.09 | 99.91 | 99.66 | 99.48 | 99.31 | 99.14 | 98.88 | 98.62 | 98.36 | 98.19 |
| 15 | 11.92 | 100.17 | 99.92 | 99.75 | 99.58 | 99.33 | 99.16 | 98.99 | 98.74 | 98.66 | 98.49 |
| 16 | 11.58 | 100.09 | 99.83 | 99.65 | 99.48 | 99.31 | 99.05 | 98.88 | 98.62 | 98.45 | 98.19 |
| 17 | 11.98 | 100.17 | 99.92 | 99.67 | 99.42 | 99.17 | 98.91 | 98.66 | 98.50 | 98.33 | 98.16 |
| 18 | 11.55 | 100.35 | 100.09 | 99.91 | 99.74 | 99.57 | 99.39 | 99.22 | 98.96 | 98.79 | 98.53 |
| 19 | 11.89 | 100.25 | 99.92 | 99.75 | 99.58 | 99.33 | 99.07 | 98.91 | 98.65 | 98.57 | 98.40 |
| 20 | 11.80 | 100.25 | 100.08 | 99.83 | 99.66 | 99.49 | 99.24 | 98.98 | 98.81 | 98.64 | 98.47 |
| 21 | 12.07 | 100.25 | 100.08 | 99.75 | 99.67 | 99.50 | 99.25 | 99.01 | 98.76 | 98.59 | 98.26 |
| 22 | 11.62 | 100.26 | 100.17 | 99.91 | 99.57 | 99.40 | 99.23 | 99.05 | 98.88 | 98.54 | 98.28 |
| 23 | 11.73 | 100.17 | 100.09 | 99.91 | 99.74 | 99.57 | 99.40 | 99.23 | 99.06 | 98.81 | 98.64 |
| 24 | 11.31 | 100.27 | 100.09 | 99.91 | 99.73 | 99.56 | 99.38 | 99.12 | 98.85 | 98.67 | 98.50 |
| 25 | 11.43 | 100.26 | 100.09 | 99.91 | 99.65 | 99.48 | 99.21 | 99.04 | 98.78 | 98.60 | 98.34 |
| Avg. | 11.68 | 100.22 | 100.01 | 99.81 | 99.63 | 99.43 | 99.22 | 99.01 | 98.80 | 98.60 | 98.39 |
| Med. | 11.71 | 100.25 | 100.08 | 99.83 | 99.66 | 99.41 | 99.24 | 98.99 | 98.80 | 98.62 | 98.40 |
| st dev | 0.22 | 0.07 | 0.11 | 0.13 | 0.14 | 0.17 | 0.18 | 0.19 | 0.18 | 0.18 | 0.18 |
| Min. | 11.17 | 100.08 | 99.83 | 99.57 | 99.33 | 99.06 | 98.82 | 98.57 | 98.40 | 98.23 | 98.07 |
| Max. | 12.07 | 100.35 | 100.18 | 100.08 | 99.92 | 99.75 | 99.49 | 99.33 | 99.15 | 98.98 | 98.81 |

### 3.2 Data Set 1, 55°C, 30mA (Forward Voltage)

| No. | Forward Voltage (V) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **0hr(Initial) | **1000hrs | **2000hrs | **3000hrs | **4000hrs | **5000hrs | **6000hrs | 7000hrs | 8000hrs | 9000hrs | 10000hrs |
| 1 | 2.889 | 2.888 | 2.888 | 2.888 | 2.888 | 2.888 | 2.889 | 2.888 | 2.887 | 2.886 | 2.890 |
| 2 | 2.873 | 2.872 | 2.873 | 2.873 | 2.872 | 2.873 | 2.877 | 2.872 | 2.872 | 2.873 | 2.873 |
| 3 | 2.881 | 2.882 | 2.883 | 2.883 | 2.880 | 2.881 | 2.886 | 2.882 | 2.881 | 2.881 | 2.884 |
| 4 | 2.870 | 2.887 | 2.887 | 2.891 | 2.886 | 2.888 | 2.889 | 2.887 | 2.888 | 2.886 | 2.886 |
| 5 | 2.879 | 2.881 | 2.882 | 2.883 | 2.880 | 2.883 | 2.882 | 2.881 | 2.880 | 2.879 | 2.881 |
| 6 | 2.878 | 2.877 | 2.877 | 2.881 | 2.877 | 2.878 | 2.878 | 2.877 | 2.877 | 2.878 | 2.878 |
| 7 | 2.884 | 2.882 | 2.883 | 2.885 | 2.883 | 2.886 | 2.885 | 2.885 | 2.885 | 2.883 | 2.883 |
| 8 | 2.877 | 2.877 | 2.879 | 2.881 | 2.880 | 2.879 | 2.881 | 2.879 | 2.880 | 2.878 | 2.878 |
| 9 | 2.886 | 2.888 | 2.888 | 2.891 | 2.886 | 2.888 | 2.889 | 2.888 | 2.891 | 2.888 | 2.887 |
| 10 | 2.876 | 2.879 | 2.882 | 2.883 | 2.880 | 2.880 | 2.880 | 2.881 | 2.880 | 2.880 | 2.881 |
| 11 | 2.879 | 2.880 | 2.883 | 2.883 | 2.884 | 2.883 | 2.882 | 2.880 | 2.882 | 2.881 | 2.881 |
| 12 | 2.883 | 2.885 | 2.886 | 2.887 | 2.888 | 2.887 | 2.888 | 2.886 | 2.885 | 2.886 | 2.886 |
| 13 | 2.878 | 2.879 | 2.881 | 2.882 | 2.882 | 2.881 | 2.880 | 2.880 | 2.881 | 2.879 | 2.881 |
| 14 | 2.883 | 2.885 | 2.888 | 2.887 | 2.884 | 2.885 | 2.885 | 2.886 | 2.886 | 2.886 | 2.885 |
| 15 | 2.877 | 2.877 | 2.878 | 2.879 | 2.879 | 2.878 | 2.879 | 2.878 | 2.878 | 2.879 | 2.878 |
| 16 | 2.870 | 2.872 | 2.874 | 2.874 | 2.874 | 2.873 | 2.873 | 2.872 | 2.872 | 2.872 | 2.873 |
| 17 | 2.879 | 2.880 | 2.880 | 2.885 | 2.882 | 2.882 | 2.881 | 2.883 | 2.884 | 2.881 | 2.882 |
| 18 | 2.879 | 2.880 | 2.880 | 2.884 | 2.881 | 2.882 | 2.881 | 2.881 | 2.882 | 2.883 | 2.882 |
| 19 | 2.885 | 2.887 | 2.888 | 2.890 | 2.890 | 2.888 | 2.888 | 2.889 | 2.889 | 2.889 | 2.896 |
| 20 | 2.885 | 2.885 | 2.887 | 2.889 | 2.888 | 2.886 | 2.887 | 2.886 | 2.887 | 2.889 | 2.887 |
| 21 | 2.888 | 2.888 | 2.891 | 2.889 | 2.895 | 2.892 | 2.890 | 2.890 | 2.893 | 2.890 | 2.890 |
| 22 | 2.879 | 2.881 | 2.879 | 2.883 | 2.886 | 2.884 | 2.885 | 2.881 | 2.885 | 2.881 | 2.882 |
| 23 | 2.886 | 2.884 | 2.887 | 2.886 | 2.889 | 2.889 | 2.892 | 2.886 | 2.889 | 2.887 | 2.887 |
| 24 | 2.884 | 2.886 | 2.888 | 2.886 | 2.888 | 2.889 | 2.899 | 2.886 | 2.890 | 2.888 | 2.887 |
| 25 | 2.866 | 2.866 | 2.867 | 2.867 | 2.877 | 2.871 | 2.875 | 2.867 | 2.872 | 2.867 | 2.867 |
| Avg. | 2.880 | 2.881 | 2.882 | 2.884 | 2.883 | 2.883 | 2.884 | 2.882 | 2.883 | 2.882 | 2.883 |
| Med. | 2.879 | 2.881 | 2.883 | 2.884 | 2.883 | 2.883 | 2.885 | 2.882 | 2.884 | 2.881 | 2.882 |
| st dev | 0.006 | 0.006 | 0.006 | 0.006 | 0.005 | 0.005 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 |
| Min. | 2.866 | 2.866 | 2.867 | 2.867 | 2.872 | 2.871 | 2.873 | 2.867 | 2.872 | 2.867 | 2.867 |
| Max. | 2.889 | 2.888 | 2.891 | 2.891 | 2.895 | 2.892 | 2.899 | 2.890 | 2.893 | 2.890 | 2.896 |

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

| No. | u' | v' | CCT(K) | Chromaticity Shift (Δu'v') | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **0hr(Initial) | | | **1000hrs | **2000hrs | **3000hrs | **4000hrs | **5000hrs | **6000hrs | 7000hrs | 8000hrs | 9000hrs | 10000hrs |
| 1 | 0.2550 | 0.5286 | 2859 | 0.0001 | 0.0002 | 0.0001 | 0.0004 | 0.0006 | 0.0007 | 0.0009 | 0.0009 | 0.0009 | 0.0009 |
| 2 | 0.2552 | 0.5267 | 2861 | 0.0001 | 0.0002 | 0.0004 | 0.0007 | 0.0008 | 0.0009 | 0.0009 | 0.0009 | 0.0011 | 0.0013 |
| 3 | 0.2608 | 0.5297 | 2725 | 0.0001 | 0.0002 | 0.0004 | 0.0004 | 0.0005 | 0.0007 | 0.0008 | 0.0008 | 0.0010 | 0.0011 |
| 4 | 0.2623 | 0.5257 | 2710 | 0.0002 | 0.0003 | 0.0002 | 0.0003 | 0.0004 | 0.0006 | 0.0008 | 0.0008 | 0.0010 | 0.0011 |
| 5 | 0.2594 | 0.5328 | 2741 | 0.0001 | 0.0002 | 0.0005 | 0.0005 | 0.0005 | 0.0006 | 0.0008 | 0.0008 | 0.0010 | 0.0011 |
| 6 | 0.2567 | 0.5249 | 2836 | 0.0001 | 0.0002 | 0.0003 | 0.0003 | 0.0005 | 0.0006 | 0.0009 | 0.0009 | 0.0011 | 0.0011 |
| 7 | 0.2591 | 0.5267 | 2774 | 0.0001 | 0.0002 | 0.0002 | 0.0003 | 0.0004 | 0.0005 | 0.0008 | 0.0008 | 0.0008 | 0.0009 |
| 8 | 0.2570 | 0.5296 | 2806 | 0.0001 | 0.0002 | 0.0002 | 0.0003 | 0.0004 | 0.0005 | 0.0009 | 0.0007 | 0.0009 | 0.0011 |
| 9 | 0.2550 | 0.5291 | 2853 | 0.0001 | 0.0002 | 0.0001 | 0.0002 | 0.0004 | 0.0005 | 0.0007 | 0.0008 | 0.0010 | 0.0010 |
| 10 | 0.2587 | 0.5323 | 2760 | 0.0001 | 0.0002 | 0.0001 | 0.0001 | 0.0003 | 0.0004 | 0.0006 | 0.0008 | 0.0008 | 0.0010 |
| 11 | 0.2561 | 0.5283 | 2832 | 0.0001 | 0.0002 | 0.0001 | 0.0003 | 0.0005 | 0.0006 | 0.0009 | 0.0010 | 0.0010 | 0.0013 |
| 12 | 0.2594 | 0.5281 | 2762 | 0.0001 | 0.0002 | 0.0001 | 0.0003 | 0.0005 | 0.0006 | 0.0009 | 0.0010 | 0.0010 | 0.0012 |
| 13 | 0.2588 | 0.5261 | 2783 | 0.0001 | 0.0002 | 0.0003 | 0.0003 | 0.0004 | 0.0006 | 0.0008 | 0.0011 | 0.0010 | 0.0011 |
| 14 | 0.2552 | 0.5297 | 2846 | 0.0001 | 0.0002 | 0.0004 | 0.0004 | 0.0005 | 0.0006 | 0.0008 | 0.0009 | 0.0009 | 0.0011 |
| 15 | 0.2588 | 0.5283 | 2775 | 0.0001 | 0.0002 | 0.0004 | 0.0003 | 0.0004 | 0.0005 | 0.0008 | 0.0010 | 0.0008 | 0.0011 |
| 16 | 0.2549 | 0.5292 | 2856 | 0.0002 | 0.0003 | 0.0002 | 0.0002 | 0.0004 | 0.0004 | 0.0007 | 0.0009 | 0.0009 | 0.0009 |
| 17 | 0.2592 | 0.5324 | 2748 | 0.0001 | 0.0002 | 0.0003 | 0.0003 | 0.0004 | 0.0004 | 0.0006 | 0.0007 | 0.0009 | 0.0009 |
| 18 | 0.2599 | 0.5328 | 2732 | 0.0001 | 0.0002 | 0.0002 | 0.0002 | 0.0004 | 0.0005 | 0.0007 | 0.0010 | 0.0010 | 0.0011 |
| 19 | 0.2592 | 0.5274 | 2770 | 0.0001 | 0.0002 | 0.0004 | 0.0004 | 0.0005 | 0.0005 | 0.0008 | 0.0010 | 0.0010 | 0.0011 |
| 20 | 0.2552 | 0.5296 | 2846 | 0.0002 | 0.0003 | 0.0002 | 0.0002 | 0.0003 | 0.0004 | 0.0006 | 0.0008 | 0.0009 | 0.0010 |
| 21 | 0.2560 | 0.5288 | 2833 | 0.0001 | 0.0002 | 0.0003 | 0.0004 | 0.0003 | 0.0004 | 0.0006 | 0.0009 | 0.0009 | 0.0009 |
| 22 | 0.2572 | 0.5273 | 2814 | 0.0001 | 0.0002 | 0.0002 | 0.0004 | 0.0004 | 0.0006 | 0.0005 | 0.0008 | 0.0009 | 0.0009 |
| 23 | 0.2574 | 0.5268 | 2812 | 0.0001 | 0.0002 | 0.0004 | 0.0007 | 0.0006 | 0.0009 | 0.0009 | 0.0011 | 0.0014 | 0.0012 |
| 24 | 0.2563 | 0.5271 | 2835 | 0.0001 | 0.0002 | 0.0003 | 0.0006 | 0.0006 | 0.0007 | 0.0007 | 0.0009 | 0.0012 | 0.0011 |
| 25 | 0.2610 | 0.5321 | 2712 | 0.0001 | 0.0002 | 0.0004 | 0.0005 | 0.0005 | 0.0006 | 0.0007 | 0.0009 | 0.0012 | 0.0009 |
| Avg. | 0.2578 | 0.5288 | 2795 | 0.0001 | 0.0002 | 0.0003 | 0.0004 | 0.0005 | 0.0006 | 0.0008 | 0.0009 | 0.0010 | 0.0011 |
| Med. | 0.2574 | 0.5286 | 2806 | 0.0001 | 0.0002 | 0.0003 | 0.0003 | 0.0004 | 0.0006 | 0.0008 | 0.0009 | 0.0010 | 0.0011 |
| st dev | 0.0022 | 0.0023 | 50 | 0.0000 | 0.0000 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 |
| Min. | 0.2549 | 0.5249 | 2710 | 0.0001 | 0.0002 | 0.0001 | 0.0001 | 0.0003 | 0.0004 | 0.0005 | 0.0007 | 0.0008 | 0.0009 |
| Max. | 0.2623 | 0.5328 | 2861 | 0.0002 | 0.0003 | 0.0005 | 0.0007 | 0.0008 | 0.0009 | 0.0009 | 0.0011 | 0.0014 | 0.0013 |

### 3.4 Data Set 2, 85°C, 30mA (Lumen Maintenance)

| No. | Φ(lm) | Lumen Maintenance (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **0hr(Initial) | **1000hrs | **2000hrs | **3000hrs | **4000hrs | **5000hrs | **6000hrs | 7000hrs | 8000hrs | 9000hrs | 10000hrs |
| 26 | 11.76 | 100.26 | 99.91 | 99.74 | 99.49 | 99.15 | 98.98 | 98.72 | 98.47 | 98.21 | 98.04 |
| 27 | 11.66 | 100.17 | 99.91 | 99.66 | 99.40 | 99.23 | 98.97 | 98.71 | 98.46 | 98.28 | 98.03 |
| 28 | 11.42 | 100.35 | 100.09 | 99.91 | 99.74 | 99.56 | 99.21 | 98.95 | 98.69 | 98.42 | 98.16 |
| 29 | 11.67 | 100.09 | 99.91 | 99.83 | 99.74 | 99.40 | 99.23 | 99.06 | 98.89 | 98.71 | 98.37 |
| 30 | 11.69 | 100.34 | 100.17 | 99.83 | 99.66 | 99.49 | 99.23 | 98.97 | 98.63 | 98.29 | 98.03 |
| 31 | 11.35 | 100.35 | 100.09 | 99.82 | 99.65 | 99.38 | 99.12 | 98.85 | 98.59 | 98.24 | 97.97 |
| 32 | 11.47 | 100.17 | 99.83 | 99.65 | 99.48 | 99.22 | 99.04 | 98.87 | 98.61 | 98.34 | 98.08 |
| 33 | 11.49 | 100.26 | 100.09 | 99.83 | 99.56 | 99.30 | 99.04 | 98.78 | 98.61 | 98.35 | 98.00 |
| 34 | 11.82 | 100.25 | 99.92 | 99.58 | 99.41 | 99.15 | 98.90 | 98.65 | 98.39 | 98.05 | 97.88 |
| 35 | 11.36 | 100.18 | 99.82 | 99.56 | 99.38 | 99.21 | 99.03 | 98.86 | 98.68 | 98.42 | 98.24 |
| 36 | 11.88 | 100.17 | 99.83 | 99.58 | 99.41 | 99.24 | 99.07 | 98.91 | 98.74 | 98.57 | 98.40 |
| 37 | 11.57 | 100.26 | 99.91 | 99.65 | 99.39 | 99.22 | 99.05 | 98.79 | 98.53 | 98.36 | 98.01 |
| 38 | 11.61 | 100.09 | 99.83 | 99.66 | 99.40 | 99.22 | 98.97 | 98.79 | 98.54 | 98.28 | 97.93 |
| 39 | 11.86 | 100.34 | 100.17 | 99.92 | 99.66 | 99.41 | 99.16 | 98.99 | 98.65 | 98.48 | 98.23 |
| 40 | 11.51 | 100.26 | 100.09 | 99.74 | 99.57 | 99.30 | 99.13 | 98.87 | 98.61 | 98.26 | 98.09 |
| 41 | 11.66 | 100.34 | 100.09 | 99.83 | 99.66 | 99.40 | 99.14 | 98.89 | 98.63 | 98.37 | 98.11 |
| 42 | 11.42 | 99.82 | 99.74 | 99.65 | 99.56 | 99.47 | 99.12 | 98.86 | 98.60 | 98.34 | 97.99 |
| 43 | 12.16 | 100.25 | 100.16 | 99.92 | 99.59 | 99.34 | 99.10 | 98.77 | 98.44 | 98.19 | 97.94 |
| 44 | 11.62 | 100.09 | 99.91 | 99.83 | 99.66 | 99.40 | 99.14 | 98.80 | 98.54 | 98.28 | 98.02 |
| 45 | 11.60 | 100.26 | 100.17 | 99.91 | 99.66 | 99.40 | 99.05 | 98.79 | 98.53 | 98.28 | 98.02 |
| 46 | 11.84 | 99.92 | 99.83 | 99.75 | 99.66 | 99.41 | 99.16 | 98.90 | 98.65 | 98.48 | 98.31 |
| 47 | 11.60 | 100.26 | 99.91 | 99.74 | 99.57 | 99.31 | 99.05 | 98.79 | 98.53 | 98.28 | 98.02 |
| 48 | 11.52 | 99.83 | 99.65 | 99.57 | 99.48 | 99.31 | 99.05 | 98.78 | 98.52 | 98.26 | 98.00 |
| 49 | 11.73 | 100.34 | 100.09 | 99.83 | 99.66 | 99.40 | 99.15 | 98.81 | 98.47 | 98.29 | 98.04 |
| 50 | 11.68 | 100.17 | 99.91 | 99.74 | 99.57 | 99.32 | 99.06 | 98.80 | 98.46 | 98.12 | 97.86 |
| Avg. | 11.64 | 100.19 | 99.96 | 99.75 | 99.56 | 99.33 | 99.09 | 98.84 | 98.58 | 98.33 | 98.07 |
| Med. | 11.62 | 100.25 | 99.91 | 99.74 | 99.57 | 99.32 | 99.07 | 98.81 | 98.59 | 98.29 | 98.03 |
| st dev | 0.19 | 0.15 | 0.15 | 0.12 | 0.11 | 0.11 | 0.08 | 0.09 | 0.11 | 0.14 | 0.14 |
| Min. | 11.35 | 99.82 | 99.65 | 99.56 | 99.38 | 99.15 | 98.90 | 98.65 | 98.39 | 98.05 | 97.86 |
| Max. | 12.16 | 100.35 | 100.17 | 99.92 | 99.74 | 99.56 | 99.23 | 99.06 | 98.89 | 98.71 | 98.40 |

### 3.5 Data Set 2, 85°C, 30mA (Forward Voltage)

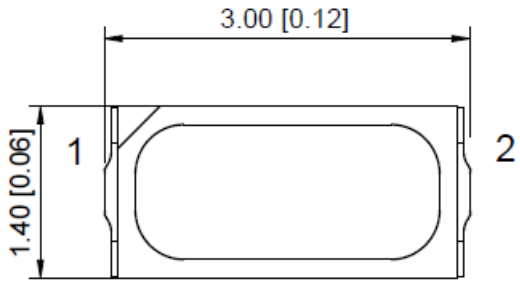
| No. | Forward Voltage (V) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **0hr(Initial) | **1000hrs | **2000hrs | **3000hrs | **4000hrs | **5000hrs | **6000hrs | 7000hrs | 8000hrs | 9000hrs | 10000hrs |
| 26 | 2.893 | 2.895 | 2.897 | 2.899 | 2.900 | 2.896 | 2.898 | 2.896 | 2.899 | 2.898 | 2.900 |
| 27 | 2.881 | 2.884 | 2.883 | 2.888 | 2.889 | 2.887 | 2.886 | 2.885 | 2.886 | 2.885 | 2.885 |
| 28 | 2.890 | 2.890 | 2.896 | 2.895 | 2.895 | 2.893 | 2.893 | 2.893 | 2.893 | 2.893 | 2.893 |
| 29 | 2.893 | 2.896 | 2.898 | 2.898 | 2.900 | 2.899 | 2.899 | 2.896 | 2.896 | 2.897 | 2.899 |
| 30 | 2.882 | 2.885 | 2.884 | 2.886 | 2.885 | 2.889 | 2.886 | 2.885 | 2.885 | 2.884 | 2.885 |
| 31 | 2.874 | 2.876 | 2.877 | 2.880 | 2.878 | 2.880 | 2.878 | 2.878 | 2.879 | 2.878 | 2.879 |
| 32 | 2.874 | 2.878 | 2.879 | 2.879 | 2.879 | 2.879 | 2.877 | 2.878 | 2.878 | 2.879 | 2.878 |
| 33 | 2.891 | 2.897 | 2.897 | 2.893 | 2.895 | 2.896 | 2.897 | 2.893 | 2.895 | 2.895 | 2.897 |
| 34 | 2.883 | 2.888 | 2.887 | 2.887 | 2.889 | 2.888 | 2.887 | 2.885 | 2.888 | 2.887 | 2.887 |
| 35 | 2.885 | 2.888 | 2.887 | 2.890 | 2.890 | 2.889 | 2.890 | 2.886 | 2.888 | 2.889 | 2.888 |
| 36 | 2.886 | 2.890 | 2.891 | 2.889 | 2.891 | 2.890 | 2.888 | 2.890 | 2.889 | 2.889 | 2.891 |
| 37 | 2.875 | 2.880 | 2.880 | 2.882 | 2.881 | 2.879 | 2.881 | 2.881 | 2.879 | 2.880 | 2.912 |
| 38 | 2.877 | 2.882 | 2.882 | 2.883 | 2.881 | 2.880 | 2.883 | 2.882 | 2.881 | 2.879 | 2.882 |
| 39 | 2.879 | 2.883 | 2.886 | 2.884 | 2.884 | 2.883 | 2.885 | 2.883 | 2.884 | 2.884 | 2.884 |
| 40 | 2.883 | 2.886 | 2.887 | 2.887 | 2.890 | 2.887 | 2.887 | 2.886 | 2.886 | 2.886 | 2.886 |
| 41 | 2.873 | 2.878 | 2.878 | 2.877 | 2.882 | 2.878 | 2.879 | 2.877 | 2.878 | 2.877 | 2.879 |
| 42 | 2.878 | 2.883 | 2.883 | 2.882 | 2.887 | 2.884 | 2.886 | 2.884 | 2.884 | 2.884 | 2.882 |
| 43 | 2.893 | 2.892 | 2.890 | 2.891 | 2.895 | 2.895 | 2.893 | 2.892 | 2.892 | 2.892 | 2.895 |
| 44 | 2.889 | 2.889 | 2.888 | 2.889 | 2.890 | 2.888 | 2.888 | 2.886 | 2.889 | 2.888 | 2.886 |
| 45 | 2.874 | 2.876 | 2.877 | 2.875 | 2.876 | 2.877 | 2.877 | 2.874 | 2.874 | 2.879 | 2.875 |
| 46 | 2.883 | 2.884 | 2.883 | 2.883 | 2.884 | 2.883 | 2.884 | 2.882 | 2.882 | 2.883 | 2.883 |
| 47 | 2.884 | 2.885 | 2.887 | 2.885 | 2.886 | 2.887 | 2.887 | 2.886 | 2.883 | 2.887 | 2.885 |
| 48 | 2.887 | 2.886 | 2.885 | 2.889 | 2.887 | 2.889 | 2.887 | 2.887 | 2.888 | 2.887 | 2.886 |
| 49 | 2.893 | 2.893 | 2.890 | 2.895 | 2.892 | 2.892 | 2.895 | 2.891 | 2.893 | 2.893 | 2.892 |
| 50 | 2.888 | 2.889 | 2.890 | 2.888 | 2.889 | 2.889 | 2.889 | 2.886 | 2.888 | 2.889 | 2.888 |
| Avg. | 2.884 | 2.886 | 2.886 | 2.887 | 2.888 | 2.887 | 2.887 | 2.886 | 2.886 | 2.886 | 2.888 |
| Med. | 2.883 | 2.886 | 2.887 | 2.887 | 2.889 | 2.888 | 2.887 | 2.886 | 2.886 | 2.887 | 2.886 |
| st dev | 0.007 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.006 | 0.008 |
| Min. | 2.873 | 2.876 | 2.877 | 2.875 | 2.876 | 2.877 | 2.877 | 2.874 | 2.874 | 2.877 | 2.875 |
| Max. | 2.893 | 2.897 | 2.898 | 2.899 | 2.900 | 2.899 | 2.899 | 2.896 | 2.899 | 2.898 | 2.912 |

### 3.6 Data Set 2, 85°C, 30mA (Chromaticity Shift)

| No. | u' | v' | CCT(K) | Chromaticity Shift (Δu'v') | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **0hr(Initial) | | | **1000hrs | **2000hrs | **3000hrs | **4000hrs | **5000hrs | **6000hrs | 7000hrs | 8000hrs | 9000hrs | 10000hrs |
| 26 | 0.2560 | 0.5308 | 2823 | 0.0001 | 0.0002 | 0.0002 | 0.0004 | 0.0004 | 0.0007 | 0.0007 | 0.0009 | 0.0011 | 0.0011 |
| 27 | 0.2563 | 0.5274 | 2832 | 0.0001 | 0.0002 | 0.0003 | 0.0006 | 0.0007 | 0.0009 | 0.0009 | 0.0010 | 0.0012 | 0.0013 |
| 28 | 0.2605 | 0.5320 | 2723 | 0.0001 | 0.0002 | 0.0004 | 0.0005 | 0.0006 | 0.0008 | 0.0007 | 0.0008 | 0.0011 | 0.0011 |
| 29 | 0.2589 | 0.5273 | 2776 | 0.0001 | 0.0002 | 0.0004 | 0.0006 | 0.0008 | 0.0010 | 0.0011 | 0.0011 | 0.0014 | 0.0014 |
| 30 | 0.2551 | 0.5271 | 2861 | 0.0001 | 0.0002 | 0.0003 | 0.0005 | 0.0006 | 0.0008 | 0.0007 | 0.0009 | 0.0011 | 0.0013 |
| 31 | 0.2620 | 0.5303 | 2699 | 0.0001 | 0.0002 | 0.0003 | 0.0005 | 0.0003 | 0.0004 | 0.0005 | 0.0006 | 0.0009 | 0.0010 |
| 32 | 0.2582 | 0.5267 | 2794 | 0.0001 | 0.0002 | 0.0003 | 0.0005 | 0.0006 | 0.0008 | 0.0008 | 0.0009 | 0.0011 | 0.0013 |
| 33 | 0.2584 | 0.5261 | 2793 | 0.0001 | 0.0002 | 0.0003 | 0.0006 | 0.0006 | 0.0009 | 0.0009 | 0.0011 | 0.0013 | 0.0011 |
| 34 | 0.2631 | 0.5312 | 2673 | 0.0001 | 0.0002 | 0.0004 | 0.0006 | 0.0006 | 0.0008 | 0.0008 | 0.0008 | 0.0011 | 0.0011 |
| 35 | 0.2618 | 0.5298 | 2705 | 0.0001 | 0.0002 | 0.0003 | 0.0005 | 0.0004 | 0.0006 | 0.0006 | 0.0008 | 0.0009 | 0.0011 |
| 36 | 0.2547 | 0.5306 | 2853 | 0.0001 | 0.0002 | 0.0003 | 0.0004 | 0.0006 | 0.0007 | 0.0008 | 0.0010 | 0.0012 | 0.0013 |
| 37 | 0.2561 | 0.5260 | 2844 | 0.0001 | 0.0002 | 0.0004 | 0.0005 | 0.0007 | 0.0007 | 0.0008 | 0.0009 | 0.0012 | 0.0013 |
| 38 | 0.2596 | 0.5302 | 2749 | 0.0001 | 0.0002 | 0.0006 | 0.0004 | 0.0006 | 0.0007 | 0.0008 | 0.0010 | 0.0011 | 0.0011 |
| 39 | 0.2556 | 0.5305 | 2833 | 0.0002 | 0.0003 | 0.0002 | 0.0004 | 0.0006 | 0.0006 | 0.0007 | 0.0008 | 0.0010 | 0.0011 |
| 40 | 0.2567 | 0.5269 | 2826 | 0.0001 | 0.0002 | 0.0004 | 0.0004 | 0.0006 | 0.0006 | 0.0007 | 0.0010 | 0.0011 | 0.0011 |
| 41 | 0.2566 | 0.5268 | 2830 | 0.0001 | 0.0002 | 0.0004 | 0.0005 | 0.0007 | 0.0008 | 0.0008 | 0.0011 | 0.0012 | 0.0013 |
| 42 | 0.2582 | 0.5311 | 2774 | 0.0001 | 0.0002 | 0.0004 | 0.0005 | 0.0007 | 0.0008 | 0.0009 | 0.0012 | 0.0013 | 0.0013 |
| 43 | 0.2550 | 0.5307 | 2845 | 0.0001 | 0.0002 | 0.0003 | 0.0005 | 0.0005 | 0.0006 | 0.0007 | 0.0010 | 0.0010 | 0.0011 |
| 44 | 0.2596 | 0.5327 | 2739 | 0.0001 | 0.0002 | 0.0003 | 0.0005 | 0.0006 | 0.0006 | 0.0007 | 0.0010 | 0.0011 | 0.0011 |
| 45 | 0.2585 | 0.5272 | 2786 | 0.0001 | 0.0002 | 0.0003 | 0.0005 | 0.0006 | 0.0006 | 0.0008 | 0.0011 | 0.0011 | 0.0012 |
| 46 | 0.2582 | 0.5286 | 2784 | 0.0001 | 0.0002 | 0.0005 | 0.0006 | 0.0007 | 0.0007 | 0.0008 | 0.0011 | 0.0011 | 0.0012 |
| 47 | 0.2623 | 0.5308 | 2690 | 0.0001 | 0.0002 | 0.0004 | 0.0005 | 0.0006 | 0.0006 | 0.0006 | 0.0010 | 0.0009 | 0.0011 |
| 48 | 0.2603 | 0.5284 | 2741 | 0.0001 | 0.0002 | 0.0005 | 0.0006 | 0.0007 | 0.0008 | 0.0009 | 0.0011 | 0.0012 | 0.0013 |
| 49 | 0.2582 | 0.5261 | 2797 | 0.0001 | 0.0002 | 0.0004 | 0.0004 | 0.0008 | 0.0008 | 0.0008 | 0.0011 | 0.0011 | 0.0013 |
| 50 | 0.2599 | 0.5328 | 2732 | 0.0001 | 0.0002 | 0.0004 | 0.0005 | 0.0006 | 0.0004 | 0.0004 | 0.0007 | 0.0007 | 0.0008 |
| Avg. | 0.2584 | 0.5291 | 2780 | 0.0001 | 0.0002 | 0.0004 | 0.0005 | 0.0006 | 0.0007 | 0.0008 | 0.0010 | 0.0011 | 0.0012 |
| Med. | 0.2582 | 0.5298 | 2786 | 0.0001 | 0.0002 | 0.0004 | 0.0005 | 0.0006 | 0.0007 | 0.0008 | 0.0010 | 0.0011 | 0.0011 |
| st dev | 0.0024 | 0.0022 | 56 | 0.0000 | 0.0000 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0001 | 0.0002 | 0.0002 | 0.0001 |
| Min. | 0.2547 | 0.5260 | 2673 | 0.0001 | 0.0002 | 0.0002 | 0.0004 | 0.0003 | 0.0004 | 0.0004 | 0.0006 | 0.0007 | 0.0008 |
| Max. | 0.2631 | 0.5328 | 2861 | 0.0002 | 0.0003 | 0.0006 | 0.0006 | 0.0008 | 0.0010 | 0.0011 | 0.0012 | 0.0014 | 0.0014 |

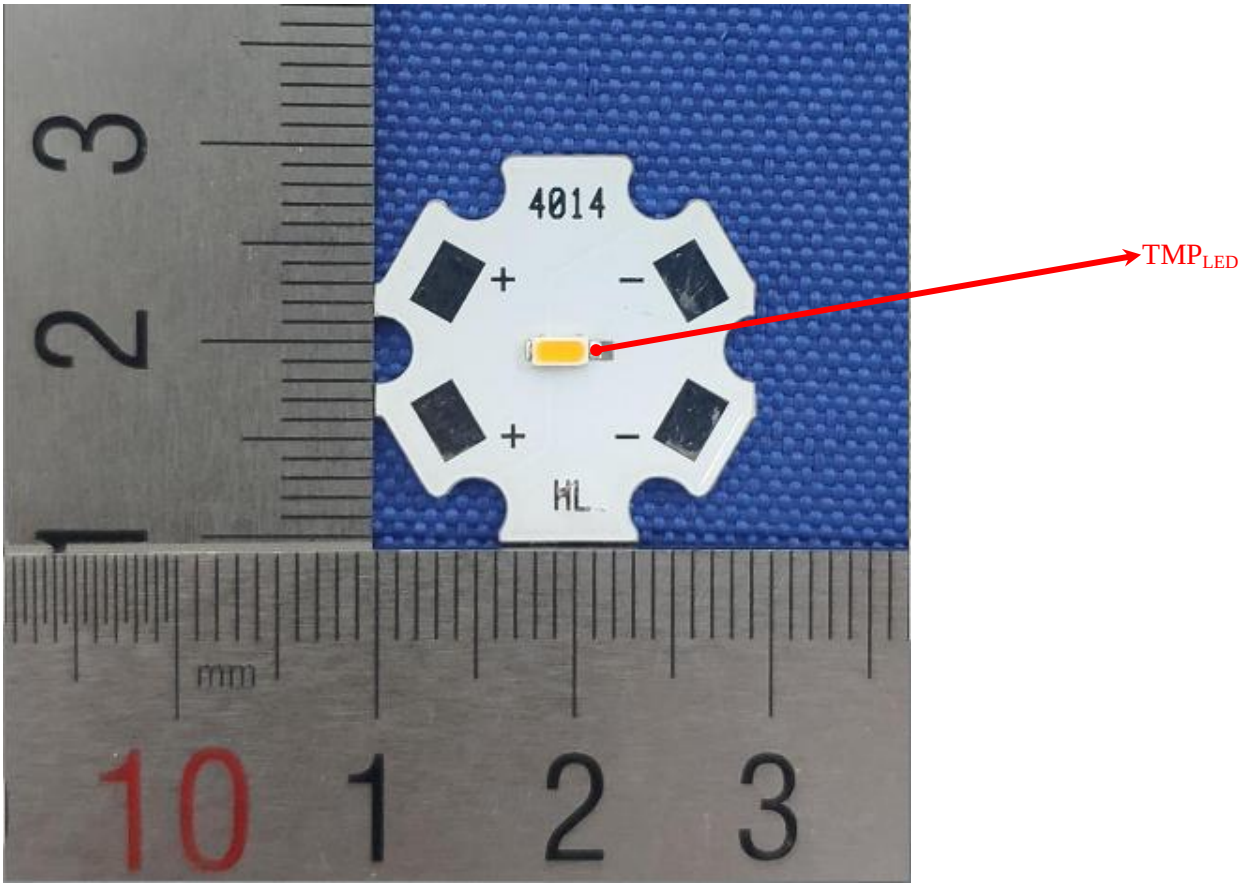
## 4 - DUT Photo

### 4.1 Mechanical Dimensions




All dimensions are in millimeter

### 4.2 DUT Photo



## Directions

1. The information marked “superscript #” is provided by the applicant, the laboratory is not responsible for its authenticity and this information can affect the validity of the result in the test report.
2. Unless otherwise stated the results shown in this test report refer only to the sample(s) tested.
3. Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.
4. The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K=2 with the 95% confidence interval.
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**********END OF REPORT**********