



# 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-LH023D101W-40B2C54(Ra2)-S-FC**

<b>Report Type:</b> 10000 Hours Test Report		<b>Product Type:</b> LED Module	
<b>Test Engineer:</b>	Pote Wang	<i>Pote Wang</i>	
<b>Report Number:</b>	RSZ190428501-10-10000		
<b>Test Date:</b>	2019-05-05 to 2020-07-23		
<b>Report Date:</b>	2020-08-11		
<b>Reviewed By:</b>	Bill Xiong / EE Engineer		
<b>Test Facility:</b>	Test facility was located at No.69,Pulongcun ,Puxinhu Industrial Area, Tangxia , Dongguan, Guangdong, China.		
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<b>Accreditation:</b>	The IAS Accreditation Number TL-460.		

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## 1 - General Information

### 1.1 Description of LED Light Sources

#### Sample Size:

24 PCS test samples were in good condition and received on 2019-04-28. The samples were numbered from 1 to 12 and 13 to 24.

#Manufacturer:	Hongli Zhihui Group Co.,Ltd. Guangzhou Branch
#Part Number:	HL-LH023D101W-40B2C54(Ra2)-S-FC
#Part Type:	LED Module
#Drive Level:	DC 300mA
#Nominal CCT:	2700K
#Power:	47.85W
#Average Current Density per LED die:	598.080mA/mm <sup>2</sup>
#Average Power Density per LED die:	1.790W/mm <sup>2</sup>
#CRI:	80
#Die Spacing:	0.3054mm

#### 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.)	CCT (typ.)	Series	Parallel	Power density (W/mm <sup>2</sup> )	Current density per LED die (mA/mm <sup>2</sup> )	Current per die (mA)	Distance between of dies	Current (mA)
Tested model	HL-LH023D101W-40B2C54(Ra2)-S-FC	80	2700K	54	2	0.1325	598.08	150	0.3054	300
Multiple models	HL-LH023D101W-40B2C54(Ra2)-S-FC	80	3000K~6500K	54	2	0.1325	598.08	150	0.3054	300
Multiple models	HL-LH023D101W-40B2C54(Ra2)-FC	80	2700K~6500K	54	2	0.1325	598.08	150	0.3054	300
Multiple models	HL-LH023D102W-38B2C54(Ra2)-S-FC	80	2700K~6500K	54	2	0.1077	582.4	120	0.3054	240
Multiple models	HL-LH023D102W-38B2C54(Ra2)-FC	80	2700K~6500K	54	2	0.1077	582.4	120	0.3054	240
Multiple models	HL-LH021D101W-8B1C16(Ra2)-S-FC	80	2700K~6500K	16	1	0.0395	598.08	150	0.4478	150
Multiple models	HL-LH021D101W-8B1C16(Ra2)-FC	80	2700K~6500K	16	1	0.0395	598.08	150	0.4478	150
Multiple models	HL-LH021D102W-5B1C16(Ra2)-S-FC	80	2700K~6500K	16	1	0.0316	582.4	120	0.4478	120
Multiple models	HL-LH021D102W-5B1C16(Ra2)-FC	80	2700K~6500K	16	1	0.0316	582.4	120	0.4478	120

Multiple models	HL-LH022D101W-8B1C16(Ra2)-S-FC	80	2700K~6500K	16	1	0.0395	598.08	150	0.4478	150
Multiple models	HL-LH022D101W-8B1C16(Ra2)-FC	80	2700K~6500K	16	1	0.0395	598.08	150	0.4478	150
Multiple models	HL-LH022D102W-5B1C16(Ra2)-S-FC	80	2700K~6500K	16	1	0.0316	582.4	120	0.4478	120
Multiple models	HL-LH022D102W-5B1C16(Ra2)-FC	80	2700K~6500K	16	1	0.0316	582.4	120	0.4478	120
Multiple models	HL-LH022D101W-12B1C26(Ra2)-S-FC	80	2700K~6500K	26	1	0.0642	598.08	150	0.7748	150
Multiple models	HL-LH022D101W-12B1C26(Ra2)-FC	80	2700K~6500K	26	1	0.0642	598.08	150	0.7748	150
Multiple models	HL-LH022D102W-7B1C26(Ra2)-S-FC	80	2700K~6500K	26	1	0.0514	582.4	120	0.7748	120
Multiple models	HL-LH022D102W-7B1C26(Ra2)-FC	80	2700K~6500K	26	1	0.0514	582.4	120	0.7748	120
Multiple models	HL-LH022D101W-18B1C36(Ra2)-S-FC	80	2700K~6500K	36	1	0.0888	598.08	150	0.6987	150
Multiple models	HL-LH022D101W-18B1C36(Ra2)-FC	80	2700K~6500K	36	1	0.0888	598.08	150	0.6987	150
Multiple models	HL-LH022D102W-10B1C36(Ra2)-S-FC	80	2700K~6500K	36	1	0.0711	582.4	120	0.6987	120
Multiple models	HL-LH022D102W-10B1C36(Ra2)-FC	80	2700K~6500K	36	1	0.0711	582.4	120	0.6987	120
Multiple models	HL-LH022D101W-20B1C42(Ra2)-S-FC	80	2700K~6500K	42	1	0.1037	598.08	150	0.4832	150
Multiple models	HL-LH022D101W-20B1C42(Ra2)-FC	80	2700K~6500K	42	1	0.1037	598.08	150	0.4832	150
Multiple models	HL-LH022D102W-12B1C42(Ra2)-S-FC	80	2700K~6500K	42	1	0.083	582.4	120	0.4832	120
Multiple models	HL-LH022D102W-12B1C42(Ra2)-FC	80	2700K~6500K	42	1	0.083	582.4	120	0.4832	120
Multiple models	HL-LH022D101W-20B1C44(Ra2)-S-FC	80	2700K~6500K	44	1	0.1086	598.08	150	0.3129	150
Multiple models	HL-LH022D101W-20B1C44(Ra2)-FC	80	2700K~6500K	44	1	0.1086	598.08	150	0.3129	150
Multiple models	HL-LH022D102W-13B1C44(Ra2)-S-FC	80	2700K~6500K	44	1	0.087	582.4	120	0.3129	120
Multiple models	HL-LH022D102W-13B1C44(Ra2)-FC	80	2700K~6500K	44	1	0.087	582.4	120	0.3129	120
Multiple models	HL-LH022D101W-12B2C13(Ra2)-S-FC	80	2700K~6500K	13	2	0.0642	598.08	150	0.7748	300
Multiple models	HL-LH022D101W-12B2C13(Ra2)-FC	80	2700K~6500K	13	2	0.0642	598.08	150	0.7748	300
Multiple models	HL-LH022D102W-7B2C13(Ra2)-S-FC	80	2700K~6500K	13	2	0.0514	582.4	120	0.7748	240
Multiple models	HL-LH022D102W-7B2C13(Ra2)-FC	80	2700K~6500K	13	2	0.0514	582.4	120	0.7748	240

Multiple models	HL-LH022D101W-20B2C21(Ra2)-S-FC	80	2700K~6500K	21	2	0.1037	598.08	150	0.4832	300
Multiple models	HL-LH022D101W-20B2C21(Ra2)-FC	80	2700K~6500K	21	2	0.1037	598.08	150	0.4832	300
Multiple models	HL-LH022D102W-12B2C21(Ra2)-S-FC	80	2700K~6500K	21	2	0.083	582.4	120	0.4832	240
Multiple models	HL-LH022D102W-12B2C21(Ra2)-FC	80	2700K~6500K	21	2	0.083	582.4	120	0.4832	240
Multiple models	HL-LH022D101W-15B1C32(Ra2)-S-FC	80	2700K~6500K	32	1	0.079	598.08	150	0.500	150
Multiple models	HL-LH022D101W-15B1C32(Ra2)-FC	80	2700K~6500K	32	1	0.079	598.08	150	0.500	150
Multiple models	HL-LH022D102W-10B1C32(Ra2)-S-FC	80	2700K~6500K	32	1	0.0632	582.4	120	0.500	120
Multiple models	HL-LH022D102W-10B1C32(Ra2)-FC	80	2700K~6500K	32	1	0.0632	582.4	120	0.500	120
Multiple models	HL-LH023D101W-24B1C54(Ra2)-S-FC	80	2700K~6500K	54	1	0.0673	598.08	150	0.6039	150
Multiple models	HL-LH023D101W-24B1C54(Ra2)-FC	80	2700K~6500K	54	1	0.0673	598.08	150	0.6039	150
Multiple models	HL-LH023D102W-15B1C54(Ra2)-S-FC	80	2700K~6500K	54	1	0.1067	582.4	120	0.6039	120
Multiple models	HL-LH023D102W-15B1C54(Ra2)-FC	80	2700K~6500K	54	1	0.1067	582.4	120	0.6039	120
Multiple models	HL-LH023D101W-25B1C60(Ra2)-S-FC	80	2700K~6500K	60	1	0.0748	598.08	150	0.4344	150
Multiple models	HL-LH023D101W-25B1C60(Ra2)-FC	80	2700K~6500K	60	1	0.0748	598.08	150	0.4344	150
Multiple models	HL-LH023D102W-18B1C60(Ra2)-S-FC	80	2700K~6500K	60	1	0.1186	582.4	120	0.4344	120
Multiple models	HL-LH023D102W-18B1C60(Ra2)-FC	80	2700K~6500K	60	1	0.1186	582.4	120	0.4344	120
Multiple models	HL-LH023D101W-24B1C86(Ra2)-S-FC	80	2700K~6500K	86	1	0.1072	598.08	150	0.4052	150
Multiple models	HL-LH023D102W-18B1C86(Ra2)-S-FC	80	2700K~6500K	86	1	0.0858	582.4	120	0.4052	120
Multiple models	HL-LH023D101W-28B2C30(Ra2)-S-FC	80	2700K~6500K	30	2	0.0748	598.08	150	0.5469	300
Multiple models	HL-LH023D101W-28B2C30(Ra2)-FC	80	2700K~6500K	30	2	0.0748	598.08	150	0.5469	300
Multiple models	HL-LH023D102W-18B2C30(Ra2)-S-FC	80	2700K~6500K	30	2	0.0599	582.4	120	0.5469	240
Multiple models	HL-LH023D102W-18B2C30(Ra2)-FC	80	2700K~6500K	30	2	0.0599	582.4	120	0.5469	240
Multiple models	HL-LH023D101W-30B2C36(Ra2)-S-FC	80	2700K~6500K	36	2	0.0897	598.08	150	0.6248	300
Multiple models	HL-LH023D101W-30B2C36(Ra2)-FC	80	2700K~6500K	36	2	0.0897	598.08	150	0.6248	300

Multiple models	HL-LH023D102W-20B2C36(Ra2)-S-FC	80	2700K~6500K	36	2	0.0718	582.4	120	0.6248	240
Multiple models	HL-LH023D102W-20B2C36(Ra2)-FC	80	2700K~6500K	36	2	0.0718	582.4	120	0.6248	240
Multiple models	HL-LH023D101W-36B2C39(Ra2)-S-FC	80	2700K~6500K	39	2	0.0972	598.08	150	0.5762	300
Multiple models	HL-LH023D101W-36B2C39(Ra2)-FC	80	2700K~6500K	39	2	0.0972	598.08	150	0.5762	300
Multiple models	HL-LH023D102W-22B2C39(Ra2)-S-FC	80	2700K~6500K	39	2	0.0778	582.4	120	0.5762	240
Multiple models	HL-LH023D102W-22B2C39(Ra2)-FC	80	2700K~6500K	39	2	0.0778	582.4	120	0.5762	240
Multiple models	HL-LH023D101W-15B3C24(Ra2)-S-FC	80	2700K~6500K	24	3	0.0897	598.08	150	0.6248	450
Multiple models	HL-LH023D101W-15B3C24(Ra2)-FC	80	2700K~6500K	24	3	0.0897	598.08	150	0.6248	450
Multiple models	HL-LH023D102W-15B3C24(Ra2)-S-FC	80	2700K~6500K	24	3	0.0718	582.4	120	0.6248	360
Multiple models	HL-LH023D102W-15B3C24(Ra2)-FC	80	2700K~6500K	24	3	0.0718	582.4	120	0.6248	360
Multiple models	HL-LH024D101W-36B8C12(Ra2)-S-FC-PM	80	2700K~6500K	12	8	0.1197	598.08	150	0.4157	1200
Multiple models	HL-LH024D102W-28B8C12(Ra2)-S-FC-PM	80	2700K~6500K	12	8	0.0958	582.4	120	0.4157	960
Multiple models	HL-LH024D101W-35B2C40(Ra2)-S-FC	80	2700K~6500K	40	2	0.0997	598.08	150	0.7052	300
Multiple models	HL-LH024D101W-35B2C40(Ra2)-FC	80	2700K~6500K	40	2	0.0997	598.08	150	0.7052	300
Multiple models	HL-LH024D102W-24B2C40(Ra2)-S-FC	80	2700K~6500K	40	2	0.0798	582.4	120	0.7052	240
Multiple models	HL-LH024D102W-24B2C40(Ra2)-FC	80	2700K~6500K	40	2	0.0798	582.4	120	0.7052	240

## 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
1.0m integrating sphere	SENSING	SCD-20008	N/A	2019-10-22	2020-10-21
spectroradiometer	SENSING	SCD-20008	N/A	2019-10-22	2020-10-21
DC Power Supply	Hanshenpu yuan	HSPY-100-05	2013010210003	2020-07-23	2021-07-22

Device	Manufacture	Model No	Serial No	Calibration date	Calibration due date
Standard Light Source	EVERFINE	D204	N/A	2019-07-19	2020-07-18
DC Power Supply	BACL	B25001	90020	2020-01-07	2021-01-07
Multilayer aging machine	BACL	B2-270	20022	2020-03-11	2021-03-10
Programmable dc power supply	Xinnuoer	PDF 1200-300	N/A	2020-07-01	2021-06-30

#### 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  $\pm 3\%$  of the specified value of the manufacturer during maintenance test, and was within  $\pm 0.5\%$  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  $2^{\circ}C$  below the corresponding nominal case temperature. Surrounding air was maintained at a temperature that was greater than or equal to  $5^{\circ}C$  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  $\pm 3\%$  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  $25^{\circ}C \pm 2^{\circ}C$ , RH <65%.

#### 1.6 Photometric Measurement Method and Uncertainty

Integrating sphere and spectroradiometer is used to measure luminous flux and chromaticity coordinate  $u'v'$ .  $2\pi$  measurement was used and sample was driven by DC power supply. The forward current was regulated to within  $\pm 0.5\%$  of the nominal value. The test system was calibrated by halogen reference lamp. The ambient temperature during test was set to  $25^{\circ}C \pm 2^{\circ}C$ , 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  $U=0.8671^{\circ}C$  ( $K=2$ ), 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: 85°C, 300mA

Part Number: HL-LH023D101W-40B2C54(Ra2)-S-FC  
Number of Units: 12  
Case Temperature: >83°C  
Ambient Temperature: >80°C  
Life Test Drive Current: 300mA  
Measurement Current: 300mA

### Data Set 2: 105°C, 300mA

Part Number: HL-LH023D101W-40B2C54(Ra2)-S-FC  
Number of Units: 12  
Case Temperature: >103°C  
Ambient Temperature: >100°C  
Life Test Drive Current: 300mA  
Measurement Current: 300mA



## 2 - Summary of Test Result

Data Set:	Sample Size	Failures Observed	Test Interval	Test Duration	$\alpha$	$\beta$	Reported TM-21 L <sub>70</sub> Lifetime	Reported TM-21 L <sub>80</sub> Lifetime	Reported TM-21 L <sub>90</sub> Lifetime
1	12	0	1000hrs	10000hrs	3.341E-06	0.993	>55000 hours	>55000 hours	30000 hours
2	12	0	1000hrs	10000hrs	4.445E-06	0.991	>55000 hours	48000 hours	22000 hours

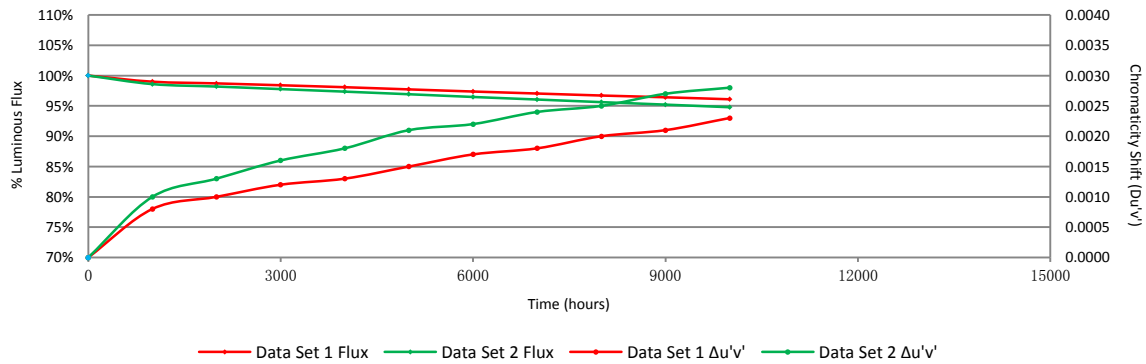
### Average Lumen Maintenance (Percentage of Initial Luminous Flux)

Data Set:	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs	10000hrs
1	98.99%	98.71%	98.40%	98.08%	97.72%	97.37%	97.04%	96.71%	96.42%	96.09%
2	98.59%	98.19%	97.77%	97.35%	96.92%	96.47%	96.05%	95.62%	95.21%	94.78%

### Average Chromaticity Shift

Data Set:	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs	10000hrs
1	0.0008	0.001	0.0012	0.0013	0.0015	0.0017	0.0018	0.0020	0.0021	0.0023
2	0.001	0.0013	0.0016	0.0018	0.0021	0.0022	0.0024	0.0025	0.0027	0.0028

### Average Lumen Maintenance and Chromaticity Shift VS. Time



### 3 - Test Data

#### 3.1 Data Set 1, 85°C, 300mA (Lumen Maintenance)

No.	Φ(lm)	Lumen Maintenance (%)									
	0hr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs	10000hrs
1	4990.29	99.36	99.07	98.69	98.45	97.84	97.58	97.21	97.01	96.68	96.47
2	5201.40	99.52	99.37	99.06	98.92	98.62	98.18	97.83	97.16	96.81	96.41
3	5224.86	98.75	98.63	98.35	97.86	97.71	97.23	97.09	96.75	96.48	96.11
4	5166.21	99.33	99.03	98.79	98.45	97.97	97.59	97.15	96.98	96.68	96.26
5	5172.08	98.79	98.40	98.12	97.88	97.52	97.10	96.85	96.52	96.25	95.91
6	5207.26	98.60	98.37	98.14	97.68	97.39	97.21	96.80	96.30	96.05	95.76
7	5189.67	98.88	98.46	98.10	97.66	97.23	97.03	96.66	96.47	96.16	95.93
8	5189.67	98.57	98.22	97.89	97.52	97.33	96.78	96.50	96.35	96.15	95.84
9	5183.81	99.13	98.94	98.61	98.33	97.86	97.56	97.14	96.95	96.61	96.41
10	5172.08	98.83	98.44	98.03	97.69	97.38	96.94	96.68	96.48	96.25	96.06
11	5218.99	98.80	98.49	98.16	97.93	97.73	97.48	97.23	96.58	96.25	95.70
12	5195.54	99.35	99.08	98.82	98.54	98.03	97.77	97.37	97.03	96.69	96.22
Avg.	5175.99	98.99	98.71	98.40	98.08	97.72	97.37	97.04	96.71	96.42	96.09
Med.	5189.67	98.85	98.56	98.26	97.90	97.72	97.36	97.12	96.66	96.37	96.08
st dev	61.27	0.33	0.37	0.38	0.45	0.39	0.40	0.37	0.30	0.26	0.27
Min.	4990.29	98.57	98.22	97.89	97.52	97.23	96.78	96.50	96.30	96.05	95.70
Max.	5224.86	99.52	99.37	99.06	98.92	98.62	98.18	97.83	97.16	96.81	96.47

**3.2 Data Set 1, 85°C, 300mA (Forward Voltage)**

No.	Forward Voltage (V)										
	0hr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs	10000hrs
1	159.38	158.77	158.36	158.60	158.53	158.70	158.80	158.77	158.54	158.58	158.39
2	159.96	159.06	157.96	158.03	157.60	157.24	156.45	156.50	156.76	157.07	157.64
3	160.44	159.93	158.42	158.68	158.03	157.64	156.60	156.87	156.10	156.26	155.65
4	161.73	160.51	159.08	159.68	159.45	159.32	158.96	158.17	157.02	157.08	155.99
5	160.31	159.11	158.02	158.13	157.75	157.48	156.83	156.61	155.74	155.65	155.69
6	160.34	159.49	158.27	158.26	157.63	156.99	156.72	156.51	156.03	156.54	156.57
7	160.21	158.15	157.56	157.73	157.91	158.26	158.79	158.37	158.48	158.17	157.97
8	160.41	159.00	157.41	158.20	158.00	158.59	158.98	158.66	158.43	158.28	157.90
9	161.30	159.70	158.64	158.85	158.60	158.56	158.27	157.64	156.72	156.67	155.70
10	160.50	159.71	158.89	158.63	158.15	157.41	156.19	156.03	155.95	155.71	155.89
11	159.92	158.78	157.56	157.34	156.50	156.44	156.54	156.28	156.12	156.37	156.46
12	160.14	158.62	157.56	157.54	157.06	156.56	156.58	156.80	157.04	157.50	158.20
Avg.	160.39	159.24	158.14	158.31	157.93	157.77	157.48	157.27	156.91	156.99	156.84
Med.	160.33	159.09	158.15	158.23	157.96	157.56	156.78	156.84	156.74	156.87	156.52
st dev	0.62	0.65	0.56	0.64	0.75	0.91	1.16	0.99	1.04	0.98	1.09
Min.	159.38	158.15	157.41	157.34	156.50	156.44	156.19	156.03	155.74	155.65	155.65
Max.	161.73	160.51	159.08	159.68	159.45	159.32	158.98	158.77	158.54	158.58	158.39

**3.3 Data Set 1, 85°C, 300mA (Chromaticity Shift)**

No.	u'	v'	CCT(K)	Chromaticity Shift ( $\Delta u'v'$ )									
				0hr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs
1	0.2628	0.5282	2692	0.0002	0.0003	0.0003	0.0003	0.0004	0.0005	0.0006	0.0008	0.0009	0.0010
2	0.2620	0.5281	2708	0.0008	0.0009	0.0011	0.0013	0.0016	0.0018	0.0020	0.0022	0.0024	0.0027
3	0.2628	0.5294	2686	0.0007	0.0011	0.0011	0.0012	0.0013	0.0014	0.0015	0.0016	0.0017	0.0017
4	0.2619	0.5281	2708	0.0009	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011	0.0011
5	0.2616	0.5256	2726	0.0008	0.0011	0.0012	0.0013	0.0014	0.0016	0.0017	0.0019	0.0021	0.0024
6	0.2623	0.5283	2700	0.0008	0.0009	0.0011	0.0014	0.0017	0.0020	0.0023	0.0025	0.0028	0.0031
7	0.2622	0.5280	2704	0.0011	0.0011	0.0013	0.0014	0.0016	0.0017	0.0018	0.0020	0.0021	0.0023
8	0.2623	0.5277	2702	0.0011	0.0013	0.0012	0.0011	0.0011	0.0010	0.0010	0.0009	0.0009	0.0009
9	0.2632	0.5295	2678	0.0007	0.0010	0.0012	0.0014	0.0016	0.0019	0.0021	0.0023	0.0025	0.0027
10	0.2627	0.5257	2704	0.0006	0.0008	0.0012	0.0016	0.0021	0.0023	0.0025	0.0027	0.0029	0.0031
11	0.2618	0.5296	2704	0.0009	0.0011	0.0014	0.0018	0.0021	0.0024	0.0027	0.0029	0.0030	0.0032
12	0.2623	0.5284	2700	0.0010	0.0013	0.0016	0.0019	0.0023	0.0027	0.0028	0.0028	0.0029	0.0030
Avg.	0.2623	0.5281	2701	0.0008	0.0010	0.0012	0.0013	0.0015	0.0017	0.0018	0.0020	0.0021	0.0023
Med.	0.2623	0.5282	2703	0.0008	0.0011	0.0012	0.0014	0.0016	0.0017	0.0019	0.0021	0.0023	0.0025
st dev	0.0005	0.0013	12	0.0002	0.0003	0.0003	0.0004	0.0005	0.0006	0.0007	0.0007	0.0008	0.0009
Min.	0.2616	0.5256	2678	0.0002	0.0003	0.0003	0.0003	0.0004	0.0005	0.0006	0.0008	0.0009	0.0009
Max.	0.2632	0.5296	2726	0.0011	0.0013	0.0016	0.0019	0.0023	0.0027	0.0028	0.0029	0.0030	0.0032

**3.4 Data Set 2, 105°C, 300mA (Lumen Maintenance)**

No.	Φ(lm)	Lumen Maintenance (%)									
	0hr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs	10000hrs
13	5324.54	98.69	98.26	97.70	97.28	96.76	96.41	95.89	95.48%	95.02%	94.45%
14	5166.21	98.60	98.29	97.63	97.08	96.48	96.00	95.48	95.28%	94.70%	94.27%
15	5201.40	98.27	97.78	97.45	97.06	96.69	96.27	95.95	95.48%	94.89%	94.53%
16	5195.54	98.21	97.87	97.28	97.13	96.60	96.11	95.91	95.48%	95.25%	94.75%
17	5142.76	98.79	98.44	98.09	97.70	97.24	96.89	96.36	95.87%	95.43%	94.86%
18	5177.94	98.66	98.30	97.99	97.33	96.78	96.20	95.92	95.48%	94.93%	94.59%
19	5189.67	98.45	97.85	97.37	96.99	96.54	96.23	95.91	95.48%	95.22%	94.84%
20	5136.89	98.93	98.63	98.29	97.87	97.52	96.93	96.26	95.87%	95.38%	95.13%
21	5177.94	98.82	98.25	97.90	97.36	97.14	96.69	96.24	95.86%	95.51%	95.03%
22	5195.54	98.58	98.19	97.89	97.53	97.03	96.68	96.17	95.61%	95.20%	94.87%
23	5095.85	98.13	97.91	97.47	97.03	96.93	96.50	96.23	95.67%	95.53%	95.03%
24	5201.40	98.96	98.54	98.22	97.88	97.34	96.72	96.33	95.86%	95.44%	95.06%
Avg.	5183.81	98.59	98.19	97.77	97.35	96.92	96.47	96.05	95.62%	95.21%	94.78%
Med.	5183.81	98.63	98.25	97.79	97.30	96.86	96.45	96.06	95.55%	95.24%	94.85%
st dev	54.55	0.28	0.28	0.34	0.32	0.34	0.31	0.26	0.20%	0.27%	0.27%
Min.	5095.85	98.13	97.78	97.28	96.99	96.48	96.00	95.48	95.28%	94.70%	94.27%
Max.	5324.54	98.96	98.63	98.29	97.88	97.52	96.93	96.36	95.87%	95.53%	95.13%

**3.5 Data Set 2, 105°C, 300mA (Forward Voltage)**

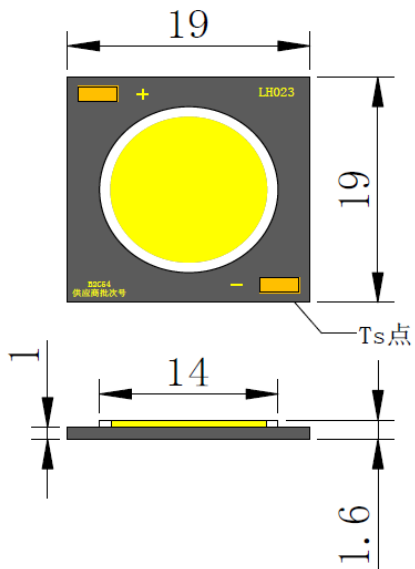
No.	Forward Voltage (V)										
	0hr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs	10000hrs
13	160.68	158.67	157.94	158.05	157.73	157.52	156.99	156.75	155.98	155.97	155.89
14	159.90	157.92	157.50	157.58	157.54	157.58	157.58	157.62	157.66	157.74	157.86
15	160.85	159.53	158.86	159.18	159.13	159.14	159.10	159.07	159.00	158.90	158.73
16	160.45	158.30	158.16	158.38	158.76	158.36	158.34	157.92	157.48	157.62	157.32
17	160.12	156.39	156.43	156.15	156.21	156.29	156.43	156.65	157.01	157.59	157.63
18	159.87	158.22	157.67	157.79	157.66	157.65	157.51	157.36	157.07	156.93	156.50
19	160.06	157.39	157.18	157.61	158.13	158.08	158.55	158.47	158.26	158.37	158.27
20	159.93	158.65	157.94	157.82	157.29	156.64	156.46	156.63	156.62	156.78	156.93
21	159.84	158.62	157.91	158.04	157.76	157.61	157.18	156.96	156.31	156.44	156.52
22	160.03	158.56	157.74	157.77	157.28	156.82	156.87	156.46	156.10	156.33	156.20
23	160.25	157.72	157.08	157.25	157.08	157.08	156.91	156.74	156.40	156.59	156.44
24	159.90	157.11	156.66	156.56	156.31	156.46	156.36	156.41	156.36	156.36	156.31
Avg.	160.16	158.09	157.59	157.68	157.57	157.44	157.36	157.25	157.02	157.14	157.05
Med.	160.05	158.26	157.71	157.78	157.60	157.55	157.09	156.86	156.82	156.86	156.73
st dev	0.34	0.84	0.67	0.79	0.86	0.84	0.89	0.86	0.93	0.90	0.90
Min.	159.84	156.39	156.43	156.15	156.21	156.29	156.36	156.41	155.98	155.97	155.89
Max.	160.85	159.53	158.86	159.18	159.13	159.14	159.10	159.07	159.00	158.90	158.73

**3.6 Data Set 2, 105°C, 300mA (Chromaticity Shift)**

No.	u'	v'	CCT(K)	Chromaticity Shift ( $\Delta u'v'$ )									
				0hr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs
13	0.2620	0.5271	2712	0.0009	0.0014	0.0015	0.0017	0.0018	0.0019	0.0021	0.0022	0.0024	0.0025
14	0.2618	0.5269	2718	0.0011	0.0012	0.0015	0.0018	0.0021	0.0023	0.0026	0.0029	0.0032	0.0035
15	0.2623	0.5297	2694	0.0004	0.0008	0.0010	0.0012	0.0014	0.0016	0.0018	0.0021	0.0023	0.0025
16	0.2626	0.5285	2694	0.0010	0.0012	0.0011	0.0011	0.0010	0.0010	0.0009	0.0009	0.0009	0.0009
17	0.2626	0.5283	2694	0.0020	0.0023	0.0026	0.0029	0.0032	0.0034	0.0035	0.0036	0.0038	0.0039
18	0.2621	0.5272	2708	0.0006	0.0007	0.0008	0.0010	0.0012	0.0014	0.0016	0.0018	0.0020	0.0023
19	0.2624	0.5273	2704	0.0012	0.0015	0.0016	0.0017	0.0018	0.0019	0.0021	0.0023	0.0024	0.0026
20	0.2621	0.5249	2718	0.0006	0.0010	0.0013	0.0017	0.0021	0.0024	0.0027	0.0030	0.0033	0.0036
21	0.2619	0.5259	2718	0.0008	0.0011	0.0014	0.0018	0.0021	0.0025	0.0026	0.0027	0.0027	0.0028
22	0.2623	0.5288	2698	0.0007	0.0010	0.0014	0.0018	0.0023	0.0024	0.0025	0.0027	0.0028	0.0030
23	0.2613	0.5255	2732	0.0013	0.0017	0.0020	0.0022	0.0025	0.0026	0.0027	0.0028	0.0029	0.0030
24	0.2618	0.5272	2716	0.0015	0.0020	0.0024	0.0028	0.0032	0.0033	0.0033	0.0034	0.0035	0.0035
Avg.	0.2621	0.5273	2709	0.0010	0.0013	0.0016	0.0018	0.0021	0.0022	0.0024	0.0025	0.0027	0.0028
Med.	0.2621	0.5272	2710	0.0010	0.0012	0.0015	0.0017	0.0021	0.0024	0.0026	0.0027	0.0028	0.0029
st dev	0.0004	0.0014	12	0.0004	0.0005	0.0005	0.0006	0.0007	0.0007	0.0007	0.0007	0.0008	0.0008
Min.	0.2613	0.5249	2694	0.0004	0.0007	0.0008	0.0010	0.0010	0.0010	0.0009	0.0009	0.0009	0.0009
Max.	0.2626	0.5297	2732	0.0020	0.0023	0.0026	0.0029	0.0032	0.0034	0.0035	0.0036	0.0038	0.0039

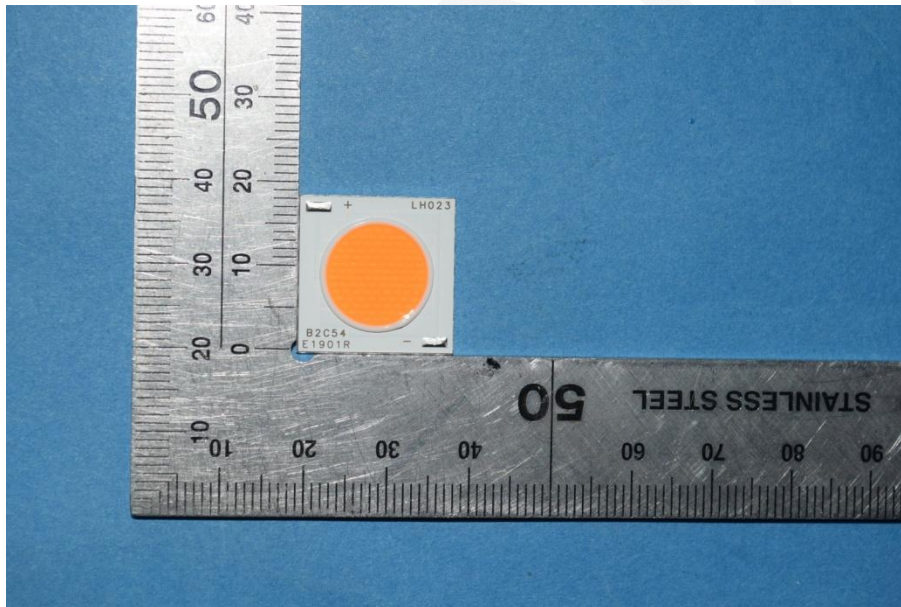
#### 4 - DUT Photo

##### 4.1 #Mechanical Dimensions



All dimensions are in millimeter

##### 4.2 DUT Photo





## Directions

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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 with the 95% confidence interval.
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\*\*\*\*\*END OF REPORT\*\*\*\*\*