



TEST REPORT

ACCORDING TO IES LM-80-2015
For

Hongli Zhihui Group Co.,Ltd.

No.1, Xianke Yi Road, Huadong Town, Huadu District, Guangzhou, China

Model: HL-ES-3032DW-3C-S1-HR3

Report Type: 9000 Hours Test Report		Product Type: LED Package	
Test Engineer:	Pote Wang <i>Pote Wang</i>		
Report Number:	RSZ160804501-10		
Test Date:	2016-08-07 to 2017-08-17		
Report Date:	2017-09-01		
Reviewed By:	Daniel Duan / EE Manager <i>Daniel Duan</i>		
Test Facility:	Test facility was located at No.69,Pulongcun ,Puxinhu Industrial Area, Tangxia , Dongguan, Guangdong, China.		
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Note: The test data was only valid for the test sample(s). This test report is prepared for the customer shown above and for the device described herein. It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. (Dongguan).

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1 - General Information

1.1 Description of LED Light Sources

Sample Size:

90 PCS samples were received on 2016-08-04. The samples were numbered from 1 to 30 , 31 to 60 and 61 to 90.

Manufacturer: Hongli Zhihui Group Co.,Ltd.
Part Number: HL-ES-3032DW-3C-S1-HR3
Part Type: LED Package
Drive Level: CC 120mA
Nominal CCT: 2700K

Family products covered by this report:

According to ENERGY STAR® Program Guidance Regarding LED Package, LED Array and LED Module Lumen Maintenance Performance Data Supporting Qualification of Lighting Products, the following products can be covered by this report base on the declaration letter of manufacturer. The information of these models shows that the covered products meet all section 3 item 7 requirements of ENERGY STAR® Program Guidance Regarding LED Package, LED Array and LED Module Lumen Maintenance Performance Data Supporting Qualification of Lighting Products (September 9, 2011)

Testing Products	Multiple Models	Details
HL-ES-3032DW-3C-S1-HR3	HL-ES-3032DW-3C-S1-HR3(R9)	Only different Model name for different market.
	HL-ES-PU3032DW-3C-S1-HR3	
	HL-ES-PU3032DW-3C-S1-HR3(R9)	
	HL-ES-3032HW-3C-S1-HR3	
	HL-ES-3032HW-3C-S1-HR3(R9)	
	HL-ES-PU3032HW-3C-S1-HR3	
	HL-ES-PU3032HW-3C-S1-HR3(R9)	

Disclaimer:

The truthfulness and accuracy of all the technical information above for the covered LED products is ensured by manufacturer of LED light source. Bay Area Compliance Laboratories Corp. (Dongguan) isn't responsible or gives any guarantees for the truthfulness of the technical information.

1.2 Standards Used:

- IESNA LM-80-15: IES Approved Method for Measuring Lumen Maintenance of LED Light Sources.
- CIE 127:2007: Measurement of LEDs

- ENERGY STAR® Program Guidance Regarding LED Package, LED Array and LED Module Lumen Maintenance Performance Data Supporting Qualification of Lighting Products(This test method was not accredited by IAS)

1.3 Testing Equipment

Device	Manufacture	Model No	Serial No	Test Range	Calibration date	Calibration due date
0.3m integrating sphere	EVERFINE	Diameter 0.3m	1011119	0.3m	2017-03-09	2018-03-09
Programmable Test Power for LEDs	EVERFINE	LED300E	1008002	15V/2000mA	2017-03-03	2018-03-03
High accuracy array spectroradiometer	EVERFINE	HAAS-2000	1012016T	380-780nm	2017-03-09	2018-03-09
Standard Light Source	EVERFINE	D062	1011093	3000K	2016-09-13	2017-09-13
Precision digital stabilized DC power supply	EVERFINE	WY605-V110	G115987CJ73 21114	300VA	2017-03-03	2018-03-03
Multilayer aging machine	BACL	B2-270	20022	25°C~130°C	2016-12-08	2017-12-08
Digital CC&CV DC Power Supply	EVERFINE	WY5015	11090004	(50/15A)	2017-03-03	2018-03-03

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 $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$, 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 driven by DC power supply. Luminous flux and chromaticity coordinate was scaled by halogen reference lamp. The ambient temperature during test was set to $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$, RH <65%.

The uncertainty of the light output measurements is $U=1.59\%$ ($K=2$), at the 95% confidence level. The uncertainty of the correlated color temperature measurements is $U=21\text{K}$ ($K=2$), at the 95% confidence level.

The uncertainty of the temperature is $U=0.8671^{\circ}\text{C}$ ($K=2$), 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, 120mA

Part Number: HL-ES-3032DW-3C-S1-HR3
Number of Units: 30
Case Temperature: >83°C
Ambient Temperature: >80°C
Life Test Drive Current: 120mA
Measurement Current: 120mA

Data Set 2: 105°C, 120mA

Part Number: HL-ES-3032DW-3C-S1-HR3
Number of Units: 30
Case Temperature: >103°C
Ambient Temperature: >100°C
Life Test Drive Current: 120mA
Measurement Current: 120mA

Data Set 3: 115° C, 120mA

Part Number: HL-ES-3032DW-3C-S1-HR3
Number of Units: 30
Case Temperature: >113°C
Ambient Temperature: >110°C
Life Test Drive Current: 120mA
Measurement Current: 120mA

2 - Summary of Test Result

Data Set:	Sample Size	Failures Observed:	Test Interval(hours)	Test Duration(hours)	Reported TM-21 L ₇₀ Lifetime
1	30	0	1000	9000	>54,000hours
2	30	0	1000	9000	>54,000hours
3	30	0	1000	9000	>54,000hours

Average Lumen Maintenance (Percentage of Initial Luminous Flux)

Data Set:	1000	2000	3000	4000	5000	6000	7000	8000	9000
1	100.24%	99.96%	99.68%	99.44%	99.21%	98.97%	98.73%	98.49%	98.23%
2	100.11%	99.74%	99.38%	99.06%	98.75%	98.47%	98.17%	97.89%	97.59%
3	99.97%	99.53%	99.07%	98.66%	98.32%	97.99%	97.68%	97.34%	97.01%

Average Color Maintenance

Data Set:	1000	2000	3000	4000	5000	6000	7000	8000	9000
1	0.0004	0.0006	0.0009	0.0011	0.0014	0.0017	0.0020	0.0022	0.0025
2	0.0005	0.0007	0.0010	0.0012	0.0015	0.0018	0.0021	0.0024	0.0026
3	0.0006	0.0009	0.0012	0.0015	0.0018	0.0020	0.0023	0.0026	0.0028

3 - Test Data

3.1 Data Set 1, 85°C, 120mA (Lumen Maintenance)

No.	Φ(lm)	Lumen Maintenance (%)								
	0hr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs
1	155.4	100.39	100.19	99.81	99.61	99.49	99.16	98.91	98.65	98.33
2	158.3	100.32	100.06	99.94	99.68	99.43	99.31	98.99	98.67	98.29
3	155.8	100.26	99.87	99.68	99.55	99.42	99.23	99.10	98.84	98.72
4	157.1	100.32	99.94	99.55	99.30	99.11	98.92	98.85	98.66	98.35
5	157.4	100.19	100.06	99.75	99.49	99.17	98.86	98.54	98.35	98.28
6	156.8	100.13	99.87	99.74	99.62	99.36	99.11	98.85	98.47	98.34
7	153.6	100.33	99.93	99.61	99.35	99.09	98.96	98.76	98.50	98.31
8	155.8	100.26	100.06	99.81	99.49	99.29	98.97	98.78	98.52	98.20
9	155.5	100.13	99.74	99.61	99.49	99.36	98.91	98.84	98.65	98.39
10	154.5	100.32	100.06	99.74	99.55	99.29	98.96	98.71	98.51	98.32
11	157.1	100.38	99.94	99.55	99.30	98.98	98.73	98.47	98.41	98.03
12	154.6	99.94	99.55	99.16	98.84	98.71	98.32	98.25	98.06	97.74
13	159.9	100.25	100.06	99.69	99.37	99.12	98.94	98.62	98.25	98.06
14	156.4	100.38	100.26	100.00	99.81	99.49	99.10	98.98	98.85	98.59
15	159.4	100.13	99.87	99.62	99.50	99.25	99.00	98.62	98.37	98.12
16	158.4	100.06	99.81	99.68	99.49	99.12	98.99	98.80	98.61	98.42
17	158.5	100.19	99.87	99.62	99.37	99.24	99.05	98.86	98.61	98.30
18	158.2	100.13	99.94	99.68	99.43	99.18	98.86	98.80	98.61	98.36
19	159.4	100.25	99.81	99.44	99.12	98.93	98.81	98.62	98.49	98.24
20	158.1	100.32	99.94	99.56	99.37	99.18	98.86	98.55	98.23	98.10
21	156.5	100.26	100.06	99.74	99.49	99.23	98.98	98.66	98.40	98.21
22	155.2	100.32	100.19	99.81	99.48	99.29	99.16	98.84	98.65	98.39
23	158.3	100.25	100.06	99.68	99.37	99.24	99.05	98.67	98.42	98.10
24	153.8	100.26	100.07	99.80	99.48	99.28	99.15	98.96	98.63	98.37
25	160.1	100.31	99.94	99.75	99.56	99.31	99.25	99.00	98.75	98.44
26	156.4	100.19	99.87	99.68	99.36	99.10	98.85	98.72	98.53	98.27
27	160.2	100.12	99.69	99.63	99.31	99.06	98.81	98.50	98.31	97.94
28	156.6	100.26	99.94	99.68	99.43	99.17	98.85	98.53	98.28	97.89
29	153.8	100.33	100.13	99.80	99.54	99.28	98.96	98.63	98.24	97.98
30	157.3	100.32	100.06	99.68	99.36	99.17	98.86	98.47	98.22	97.90
Ave.	156.9	100.24	99.96	99.68	99.44	99.21	98.97	98.73	98.49	98.23
Med.	157.0	100.26	99.94	99.68	99.48	99.24	98.96	98.74	98.51	98.29
st dev	1.9150	0.1045	0.1553	0.1515	0.1750	0.1661	0.1893	0.1934	0.1952	0.2137
Min.	153.6	99.94	99.55	99.16	98.84	98.71	98.32	98.25	98.06	97.74
Max.	160.2	100.39	100.26	100.00	99.81	99.49	99.31	99.10	98.85	98.72

TM-21 Projection:

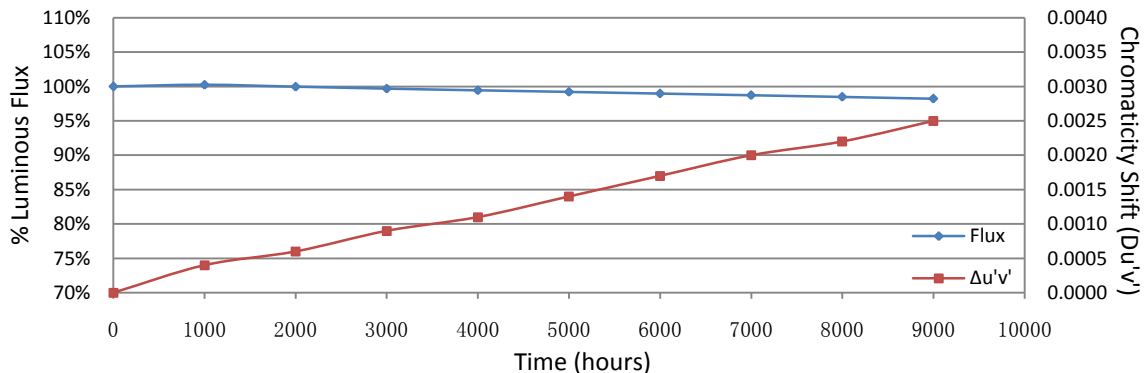
Test Duration: 9,000 hours
Failures Observed: 0
 α : 2.443E-06
 β : 1.004
Reported L₇₀: >54,000 hours

3.2 Data Set 1, 85°C, 120mA (Forward Voltage)

No.	Forward Voltage (V)									
	0hr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs
1	9.318	9.192	9.212	9.214	9.217	9.239	9.209	9.217	9.216	9.216
2	9.249	9.113	9.130	9.139	9.136	9.154	9.136	9.134	9.138	9.133
3	9.300	9.153	9.166	9.175	9.171	9.189	9.161	9.173	9.175	9.180
4	9.282	9.161	9.171	9.174	9.170	9.192	9.167	9.176	9.178	9.174
5	9.297	9.175	9.181	9.187	9.186	9.211	9.182	9.193	9.192	9.184
6	9.303	9.170	9.175	9.185	9.184	9.208	9.177	9.179	9.186	9.174
7	9.267	9.120	9.130	9.132	9.134	9.160	9.135	9.135	9.131	9.134
8	9.290	9.161	9.171	9.176	9.174	9.190	9.172	9.179	9.167	9.172
9	9.337	9.208	9.216	9.223	9.220	9.241	9.218	9.225	9.217	9.216
10	9.292	9.156	9.163	9.170	9.169	9.191	9.165	9.169	9.164	9.164
11	9.247	9.114	9.123	9.126	9.123	9.146	9.123	9.123	9.130	9.113
12	9.296	9.149	9.161	9.164	9.164	9.182	9.166	9.155	9.161	9.153
13	9.295	9.138	9.147	9.148	9.145	9.171	9.144	9.146	9.151	9.139
14	9.376	9.222	9.230	9.241	9.235	9.265	9.232	9.229	9.241	9.235
15	9.268	9.136	9.144	9.149	9.144	9.167	9.135	9.138	9.142	9.143
16	9.276	9.147	9.153	9.160	9.169	9.192	9.158	9.163	9.161	9.153
17	9.256	9.133	9.142	9.148	9.146	9.173	9.142	9.145	9.141	9.141
18	9.302	9.159	9.168	9.168	9.177	9.201	9.161	9.169	9.167	9.166
19	9.299	9.165	9.170	9.173	9.176	9.193	9.171	9.174	9.167	9.167
20	9.259	9.142	9.145	9.143	9.150	9.173	9.136	9.144	9.139	9.150
21	9.251	9.132	9.130	9.138	9.145	9.155	9.134	9.131	9.130	9.142
22	9.294	9.162	9.171	9.167	9.174	9.193	9.164	9.167	9.165	9.166
23	9.319	9.154	9.155	9.165	9.172	9.190	9.161	9.154	9.159	9.159
24	9.345	9.186	9.187	9.191	9.210	9.214	9.192	9.199	9.184	9.195
25	9.355	9.196	9.202	9.203	9.204	9.237	9.202	9.203	9.202	9.207
26	9.308	9.179	9.183	9.194	9.195	9.217	9.186	9.199	9.189	9.189
27	9.291	9.144	9.151	9.152	9.152	9.176	9.155	9.160	9.143	9.157
28	9.364	9.217	9.224	9.228	9.235	9.254	9.229	9.233	9.229	9.236
29	9.338	9.177	9.180	9.190	9.183	9.204	9.183	9.191	9.182	9.197
30	9.363	9.208	9.214	9.221	9.218	9.240	9.212	9.218	9.205	9.215
Ave.	9.301	9.162	9.170	9.175	9.176	9.197	9.170	9.174	9.172	9.172
Med.	9.297	9.160	9.169	9.172	9.173	9.192	9.166	9.171	9.167	9.167
st dev	0.0358	0.0294	0.0292	0.0300	0.0302	0.0307	0.0296	0.0312	0.0301	0.0314
Min.	9.247	9.113	9.123	9.126	9.123	9.146	9.123	9.123	9.130	9.113
Max.	9.376	9.222	9.230	9.241	9.235	9.265	9.232	9.233	9.241	9.236

3.3 Data Set 1, 85°C, 120mA (Chromaticity Shift)

No.	u'	v'	CCT(K)	Chromaticity Shift ($\Delta u'v'$)								
				0hr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs
1	0.2588	0.5292	2769	0.0004	0.0006	0.0008	0.0012	0.0014	0.0017	0.0019	0.0022	0.0024
2	0.2584	0.5289	2779	0.0003	0.0006	0.0007	0.0011	0.0013	0.0016	0.0019	0.0021	0.0025
3	0.2606	0.5301	2729	0.0002	0.0005	0.0008	0.0010	0.0012	0.0016	0.0019	0.0020	0.0023
4	0.2590	0.5298	2762	0.0002	0.0004	0.0008	0.0010	0.0013	0.0016	0.0019	0.0021	0.0024
5	0.2588	0.5280	2776	0.0005	0.0007	0.0009	0.0011	0.0014	0.0017	0.0019	0.0022	0.0025
6	0.2564	0.5289	2824	0.0004	0.0006	0.0008	0.0011	0.0013	0.0016	0.0019	0.0021	0.0025
7	0.2590	0.5272	2776	0.0003	0.0006	0.0008	0.0010	0.0013	0.0016	0.0019	0.0021	0.0025
8	0.2586	0.5311	2765	0.0003	0.0006	0.0009	0.0011	0.0014	0.0017	0.0020	0.0022	0.0025
9	0.2593	0.5289	2760	0.0003	0.0006	0.0008	0.0011	0.0013	0.0016	0.0019	0.0020	0.0025
10	0.2600	0.5295	2742	0.0004	0.0006	0.0009	0.0011	0.0014	0.0016	0.0020	0.0022	0.0025
11	0.2605	0.5295	2733	0.0004	0.0006	0.0009	0.0012	0.0014	0.0018	0.0022	0.0024	0.0029
12	0.2593	0.5278	2765	0.0004	0.0007	0.0010	0.0013	0.0016	0.0019	0.0022	0.0024	0.0029
13	0.2568	0.5272	2822	0.0003	0.0006	0.0009	0.0011	0.0014	0.0016	0.0020	0.0023	0.0027
14	0.2581	0.5284	2788	0.0006	0.0008	0.0011	0.0014	0.0016	0.0019	0.0022	0.0025	0.0031
15	0.2561	0.5298	2824	0.0002	0.0005	0.0008	0.0010	0.0013	0.0017	0.0020	0.0023	0.0028
16	0.2581	0.5279	2791	0.0003	0.0005	0.0007	0.0010	0.0013	0.0015	0.0018	0.0020	0.0024
17	0.2578	0.5288	2794	0.0003	0.0004	0.0008	0.0010	0.0013	0.0016	0.0019	0.0021	0.0023
18	0.2587	0.5275	2780	0.0004	0.0006	0.0008	0.0011	0.0013	0.0017	0.0019	0.0021	0.0025
19	0.2560	0.5276	2838	0.0003	0.0006	0.0009	0.0010	0.0014	0.0016	0.0019	0.0022	0.0025
20	0.2581	0.5277	2791	0.0004	0.0006	0.0008	0.0010	0.0013	0.0016	0.0019	0.0021	0.0025
21	0.2564	0.5292	2822	0.0003	0.0006	0.0008	0.0010	0.0013	0.0016	0.0019	0.0021	0.0023
22	0.2575	0.5275	2806	0.0003	0.0004	0.0008	0.0010	0.0013	0.0016	0.0019	0.0021	0.0023
23	0.2597	0.5274	2758	0.0004	0.0005	0.0008	0.0010	0.0013	0.0017	0.0020	0.0021	0.0024
24	0.2585	0.5297	2774	0.0003	0.0005	0.0009	0.0010	0.0013	0.0016	0.0020	0.0022	0.0024
25	0.2558	0.5276	2844	0.0004	0.0006	0.0009	0.0011	0.0013	0.0016	0.0019	0.0022	0.0023
26	0.2577	0.5303	2788	0.0004	0.0006	0.0009	0.0011	0.0014	0.0016	0.0020	0.0023	0.0023
27	0.2581	0.5295	2784	0.0002	0.0006	0.0008	0.0011	0.0014	0.0016	0.0019	0.0022	0.0024
28	0.2589	0.5294	2767	0.0003	0.0006	0.0009	0.0011	0.0014	0.0016	0.0020	0.0021	0.0024
29	0.2589	0.5296	2766	0.0003	0.0006	0.0008	0.0011	0.0013	0.0016	0.0019	0.0021	0.0024
30	0.2590	0.5300	2761	0.0003	0.0005	0.0009	0.0010	0.0013	0.0015	0.0019	0.0022	0.0022
Ave.	0.2583	0.5288	2783	0.0004	0.0006	0.0009	0.0011	0.0014	0.0017	0.0020	0.0022	0.0025
Med.	0.2586	0.5289	2778	0.0003	0.0006	0.0008	0.0011	0.0013	0.0016	0.0019	0.0021	0.0025
st dev	0.0013	0.0011	29.2098	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002
Min.	0.2558	0.5272	2729	0.0002	0.0004	0.0007	0.0010	0.0012	0.0015	0.0018	0.0020	0.0022
Max.	0.2606	0.5311	2844	0.0006	0.0008	0.0011	0.0014	0.0016	0.0019	0.0022	0.0025	0.0031



3.4 Data Set 2, 105°C, 120mA (Lumen Maintenance)

No.	Φ(lm)	Lumen Maintenance (%)								
	Ohr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs
31	157.5	100.25	99.94	99.68	99.49	99.11	98.86	98.54	98.22	97.90
32	158.6	100.32	99.87	99.50	99.24	98.99	98.68	98.49	98.42	98.11
33	157.4	100.25	99.81	99.43	99.11	98.79	98.67	98.41	98.16	98.03
34	155.5	100.26	99.74	99.36	99.10	98.78	98.52	98.14	97.88	97.62
35	157.7	100.13	99.81	99.49	99.24	98.92	98.60	98.22	97.91	97.53
36	157.1	99.94	99.68	99.30	98.98	98.79	98.54	98.35	98.15	97.84
37	156.8	100.13	99.62	99.30	99.04	98.66	98.34	98.09	97.96	97.70
38	159.2	99.87	99.50	99.12	98.81	98.49	98.18	97.80	97.49	97.11
39	154.5	100.19	99.94	99.48	99.09	98.77	98.45	98.06	97.80	97.28
40	157.3	100.13	99.75	99.49	99.17	98.86	98.54	98.22	97.97	97.77
41	156.7	100.06	99.68	99.36	99.11	98.98	98.60	98.21	97.89	97.57
42	158.2	99.94	99.62	99.30	98.93	98.61	98.29	97.98	97.79	97.66
43	158.2	100.19	99.81	99.37	98.99	98.67	98.23	98.04	97.79	97.47
44	157.9	100.06	99.68	99.24	99.05	98.86	98.48	98.16	97.78	97.34
45	157.0	100.25	99.81	99.49	99.17	98.85	98.66	98.34	98.09	97.96
46	155.3	100.19	99.87	99.55	99.16	98.91	98.84	98.45	98.33	97.94
47	153.9	99.87	99.61	99.35	98.96	98.70	98.57	98.31	98.05	97.79
48	155.6	100.06	99.68	99.29	98.84	98.46	98.20	98.01	97.81	97.69
49	156.4	100.19	99.74	99.23	98.91	98.47	98.15	97.89	97.51	97.31
50	156.7	100.32	99.87	99.36	99.04	98.72	98.53	98.15	97.83	97.57
51	157.0	100.25	99.94	99.55	99.17	98.79	98.54	98.09	97.77	97.39
52	154.2	100.06	99.74	99.48	99.16	98.83	98.51	98.18	97.73	97.54
53	156.1	99.87	99.49	99.23	98.91	98.78	98.53	98.14	97.82	97.50
54	157.2	100.06	99.55	99.30	98.92	98.60	98.35	98.22	97.77	97.52
55	156.7	99.87	99.49	99.17	98.72	98.34	98.02	97.83	97.57	97.13
56	154.7	100.06	99.74	99.29	98.97	98.51	98.13	97.87	97.67	97.48
57	156.6	99.94	99.55	99.23	98.98	98.66	98.40	98.02	97.57	97.25
58	157.0	100.25	99.87	99.55	99.24	98.98	98.66	98.34	98.03	97.58
59	159.0	100.13	99.87	99.37	98.99	98.74	98.49	98.30	97.92	97.61
60	155.1	100.26	99.94	99.55	99.16	98.90	98.58	98.26	97.87	97.61
Ave.	156.7	100.11	99.74	99.38	99.06	98.75	98.47	98.17	97.89	97.59
Med.	156.9	100.13	99.74	99.36	99.05	98.78	98.52	98.17	97.85	97.58
st dev	1.3750	0.1428	0.1409	0.1342	0.1561	0.1804	0.2061	0.1925	0.2263	0.2534
Min.	153.9	99.87	99.49	99.12	98.72	98.34	98.02	97.80	97.49	97.11
Max.	159.2	100.32	99.94	99.68	99.49	99.11	98.86	98.54	98.42	98.11

TM-21 Projection:

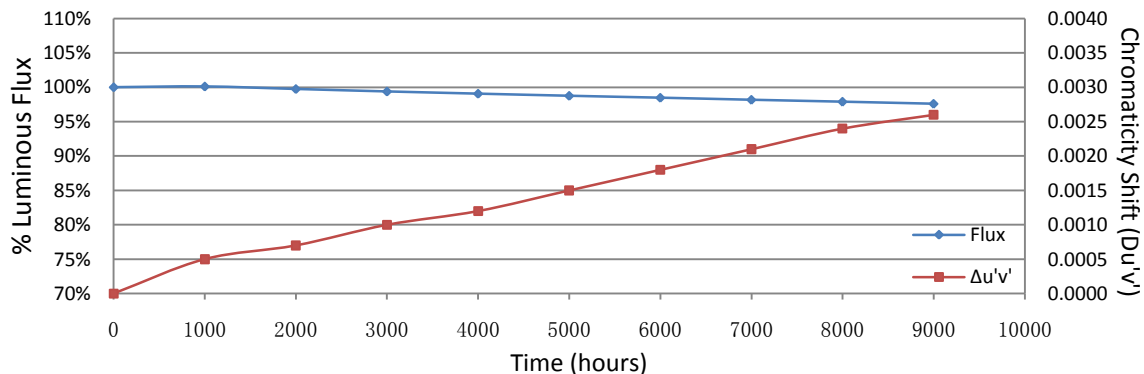
Test Duration: 9,000 hours
Failures Observed: 0
 α : 2.973E-06
 β : 1.002
Reported L₇₀: >54,000 hours

3.5 Data Set 2, 105°C, 120mA (Forward Voltage)

No.	Forward Voltage (V)									
	0hr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs
31	9.276	9.117	9.117	9.124	9.137	9.148	9.120	9.127	9.124	9.123
32	9.296	9.154	9.166	9.170	9.177	9.192	9.162	9.165	9.166	9.171
33	9.349	9.205	9.206	9.210	9.219	9.234	9.211	9.211	9.209	9.218
34	9.301	9.156	9.167	9.171	9.175	9.186	9.158	9.159	9.167	9.172
35	9.270	9.104	9.116	9.121	9.123	9.142	9.115	9.110	9.114	9.121
36	9.367	9.200	9.200	9.209	9.218	9.232	9.205	9.200	9.199	9.201
37	9.293	9.154	9.164	9.163	9.173	9.192	9.160	9.159	9.157	9.164
38	9.313	9.164	9.173	9.179	9.185	9.198	9.167	9.170	9.175	9.173
39	9.297	9.152	9.162	9.161	9.162	9.179	9.149	9.151	9.161	9.161
40	9.303	9.122	9.141	9.138	9.140	9.159	9.130	9.128	9.136	9.138
41	9.360	9.193	9.202	9.206	9.210	9.226	9.203	9.195	9.202	9.204
42	9.351	9.188	9.207	9.204	9.213	9.229	9.193	9.195	9.206	9.197
43	9.273	9.128	9.132	9.133	9.144	9.152	9.133	9.129	9.128	9.126
44	9.359	9.212	9.217	9.220	9.232	9.244	9.212	9.219	9.218	9.223
45	9.378	9.230	9.237	9.238	9.246	9.260	9.231	9.235	9.238	9.234
46	9.325	9.179	9.186	9.184	9.197	9.205	9.176	9.187	9.196	9.181
47	9.285	9.135	9.143	9.148	9.153	9.161	9.139	9.145	9.157	9.152
48	9.329	9.171	9.183	9.187	9.191	9.205	9.179	9.183	9.189	9.183
49	9.375	9.217	9.223	9.228	9.233	9.242	9.210	9.223	9.232	9.226
50	9.312	9.167	9.173	9.175	9.178	9.196	9.168	9.172	9.177	9.170
51	9.318	9.174	9.179	9.178	9.183	9.201	9.173	9.174	9.186	9.181
52	9.303	9.164	9.166	9.167	9.174	9.189	9.164	9.169	9.168	9.174
53	9.308	9.179	9.182	9.182	9.191	9.210	9.178	9.184	9.181	9.190
54	9.364	9.231	9.235	9.235	9.240	9.254	9.229	9.235	9.236	9.239
55	9.372	9.225	9.229	9.234	9.234	9.251	9.224	9.222	9.231	9.228
56	9.307	9.184	9.190	9.196	9.199	9.214	9.181	9.188	9.192	9.195
57	9.293	9.167	9.165	9.178	9.180	9.194	9.169	9.175	9.179	9.179
58	9.341	9.217	9.227	9.233	9.235	9.245	9.223	9.225	9.227	9.226
59	9.288	9.146	9.151	9.152	9.166	9.178	9.147	9.150	9.159	9.156
60	9.324	9.180	9.191	9.196	9.197	9.216	9.192	9.194	9.193	9.195
Ave.	9.321	9.174	9.181	9.184	9.190	9.204	9.177	9.179	9.183	9.183
Med.	9.313	9.173	9.181	9.181	9.188	9.203	9.175	9.179	9.184	9.181
st dev	0.0330	0.0341	0.0333	0.0335	0.0331	0.0330	0.0327	0.0336	0.0336	0.0329
Min.	9.270	9.104	9.116	9.121	9.123	9.142	9.115	9.110	9.114	9.121
Max.	9.378	9.231	9.237	9.238	9.246	9.260	9.231	9.235	9.238	9.239

3.6 Data Set 2, 105°C, 120mA (Chromaticity Shift)

No.	u'	v'	CCT(K)	Chromaticity Shift ($\Delta u'v'$)								
				0hr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs
31	0.2592	0.5269	2772	0.0004	0.0007	0.0009	0.0012	0.0016	0.0018	0.0021	0.0024	0.0025
32	0.2581	0.5278	2791	0.0004	0.0007	0.0009	0.0012	0.0015	0.0017	0.0020	0.0023	0.0024
33	0.2567	0.5289	2818	0.0005	0.0007	0.0011	0.0012	0.0015	0.0018	0.0021	0.0024	0.0026
34	0.2560	0.5282	2836	0.0005	0.0008	0.0011	0.0013	0.0016	0.0018	0.0021	0.0025	0.0027
35	0.2575	0.5289	2800	0.0004	0.0007	0.0010	0.0012	0.0015	0.0017	0.0020	0.0024	0.0026
36	0.2586	0.5304	2769	0.0005	0.0008	0.0010	0.0012	0.0015	0.0018	0.0021	0.0025	0.0026
37	0.2581	0.5286	2788	0.0005	0.0007	0.0010	0.0013	0.0015	0.0017	0.0021	0.0024	0.0026
38	0.2572	0.5299	2801	0.0005	0.0007	0.0010	0.0012	0.0015	0.0017	0.0020	0.0024	0.0025
39	0.2593	0.5280	2765	0.0004	0.0006	0.0009	0.0012	0.0015	0.0017	0.0020	0.0024	0.0025
40	0.2590	0.5283	2769	0.0005	0.0007	0.0011	0.0013	0.0016	0.0018	0.0021	0.0024	0.0026
41	0.2586	0.5297	2772	0.0004	0.0007	0.0010	0.0012	0.0015	0.0017	0.0021	0.0024	0.0026
42	0.2583	0.5263	2795	0.0006	0.0008	0.0010	0.0013	0.0016	0.0019	0.0022	0.0025	0.0028
43	0.2588	0.5292	2770	0.0004	0.0006	0.0009	0.0012	0.0015	0.0017	0.0020	0.0024	0.0025
44	0.2594	0.5281	2762	0.0004	0.0007	0.0010	0.0012	0.0015	0.0017	0.0021	0.0024	0.0026
45	0.2583	0.5292	2781	0.0006	0.0007	0.0011	0.0012	0.0015	0.0018	0.0021	0.0024	0.0027
46	0.2587	0.5296	2771	0.0007	0.0008	0.0011	0.0013	0.0016	0.0018	0.0020	0.0023	0.0027
47	0.2582	0.5273	2792	0.0004	0.0007	0.0010	0.0012	0.0015	0.0017	0.0021	0.0023	0.0025
48	0.2594	0.5286	2759	0.0004	0.0007	0.0010	0.0012	0.0015	0.0017	0.0020	0.0022	0.0025
49	0.2593	0.5291	2759	0.0004	0.0007	0.0010	0.0010	0.0014	0.0016	0.0019	0.0023	0.0027
50	0.2592	0.5301	2759	0.0004	0.0007	0.0010	0.0012	0.0015	0.0018	0.0021	0.0024	0.0026
51	0.2582	0.5300	2779	0.0004	0.0007	0.0010	0.0012	0.0015	0.0018	0.0020	0.0024	0.0025
52	0.2595	0.5288	2757	0.0007	0.0009	0.0012	0.0014	0.0017	0.0020	0.0022	0.0025	0.0028
53	0.2575	0.5292	2798	0.0004	0.0007	0.0009	0.0012	0.0015	0.0017	0.0020	0.0024	0.0025
54	0.2600	0.5308	2737	0.0004	0.0007	0.0010	0.0012	0.0014	0.0018	0.0021	0.0024	0.0025
55	0.2584	0.5296	2777	0.0004	0.0007	0.0010	0.0012	0.0015	0.0017	0.0021	0.0024	0.0026
56	0.2581	0.5275	2792	0.0004	0.0007	0.0010	0.0012	0.0016	0.0017	0.0021	0.0024	0.0026
57	0.2588	0.5292	2770	0.0004	0.0007	0.0010	0.0012	0.0015	0.0018	0.0020	0.0023	0.0025
58	0.2583	0.5300	2777	0.0004	0.0007	0.0010	0.0012	0.0015	0.0018	0.0021	0.0023	0.0026
59	0.2558	0.5269	2847	0.0004	0.0007	0.0010	0.0012	0.0015	0.0017	0.0020	0.0024	0.0027
60	0.2591	0.5282	2769	0.0004	0.0006	0.0009	0.0011	0.0015	0.0017	0.0020	0.0023	0.0026
Ave.	0.2584	0.5288	2781	0.0005	0.0007	0.0010	0.0012	0.0015	0.0018	0.0021	0.0024	0.0026
Med.	0.2585	0.5289	2775	0.0004	0.0007	0.0010	0.0012	0.0015	0.0017	0.0021	0.0024	0.0026
st dev	0.0010	0.0011	23.4446	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Min.	0.2558	0.5263	2737	0.0004	0.0006	0.0009	0.0010	0.0014	0.0016	0.0019	0.0022	0.0024
Max.	0.2600	0.5308	2847	0.0007	0.0009	0.0012	0.0014	0.0017	0.0020	0.0022	0.0025	0.0028



3.7 Data Set 3, 115° C, 120mA (Lumen Maintenance)

No.	Φ(lm)	Lumen Maintenance (%)								
		0hr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs
61	154.4	99.94	99.55	99.03	98.64	98.38	98.12	97.67	97.41	97.15
62	154.8	100.26	99.94	99.55	99.10	98.77	98.45	98.32	97.87	97.67
63	157.4	100.13	99.68	99.43	99.05	98.67	98.28	97.84	97.33	96.95
64	155.9	100.06	99.49	99.17	98.91	98.59	98.40	98.08	97.63	97.18
65	158.8	100.19	99.75	99.24	98.80	98.61	98.36	97.92	97.67	97.36
66	157.2	100.13	99.81	99.43	99.05	98.79	98.47	98.28	98.03	97.84
67	159.2	99.94	99.56	99.18	98.81	98.62	98.30	97.99	97.68	97.36
68	156.5	99.87	99.42	98.98	98.72	98.47	98.21	97.96	97.57	97.44
69	155.3	99.81	99.23	98.84	98.45	98.13	97.94	97.55	97.30	96.97
70	154.8	99.87	99.42	98.97	98.51	98.13	97.80	97.48	97.29	96.96
71	155.1	99.81	99.42	98.90	98.58	98.26	97.81	97.49	97.23	96.78
72	154.3	99.87	99.42	98.90	98.38	98.12	97.73	97.54	97.15	96.82
73	156.9	99.94	99.43	98.92	98.53	98.15	97.71	97.32	97.07	96.88
74	157.4	99.87	99.49	98.98	98.54	98.22	97.84	97.52	97.08	96.70
75	156.6	100.06	99.74	99.17	98.79	98.40	98.02	97.70	97.38	96.93
76	157.1	99.81	99.43	98.92	98.66	98.35	97.90	97.52	97.26	96.88
77	157.5	99.94	99.43	98.98	98.67	98.35	97.97	97.52	97.14	96.89
78	157.5	100.13	99.87	99.43	98.92	98.41	98.03	97.65	97.33	96.95
79	156.2	99.94	99.49	99.17	98.72	98.27	98.02	97.76	97.31	96.99
80	159.8	99.81	99.44	99.12	98.69	98.25	98.00	97.68	97.50	97.12
81	156.7	99.87	99.43	99.04	98.72	98.34	97.96	97.64	97.32	96.94
82	156.7	100.13	99.62	99.23	98.85	98.53	98.15	97.83	97.51	97.19
83	154.1	99.94	99.55	99.22	98.77	98.44	98.12	97.73	97.47	97.08
84	157.4	100.06	99.62	99.11	98.67	98.28	98.16	97.97	97.71	97.20
85	157.3	99.94	99.49	98.98	98.54	98.09	97.84	97.58	97.20	96.82
86	155.0	100.06	99.55	98.97	98.58	98.06	97.61	97.42	96.90	96.45
87	158.2	99.87	99.43	98.80	98.36	97.91	97.53	97.35	96.97	96.59
88	154.6	99.94	99.35	98.77	98.25	97.87	97.61	97.35	96.90	96.44
89	160.9	99.88	99.38	98.82	98.26	97.82	97.51	97.14	96.77	96.46
90	160.2	99.94	99.50	98.88	98.38	98.19	97.82	97.63	97.38	97.19
Ave.	156.8	99.97	99.53	99.07	98.66	98.32	97.99	97.68	97.34	97.01
Med.	156.8	99.94	99.49	99.01	98.67	98.31	97.98	97.64	97.33	96.96
st dev	1.7956	0.1240	0.1615	0.2046	0.2224	0.2498	0.2691	0.2762	0.2903	0.3289
Min.	154.1	99.81	99.23	98.77	98.25	97.82	97.51	97.14	96.77	96.44
Max.	160.9	100.26	99.94	99.55	99.10	98.79	98.47	98.32	98.03	97.84

TM-21 Projection:

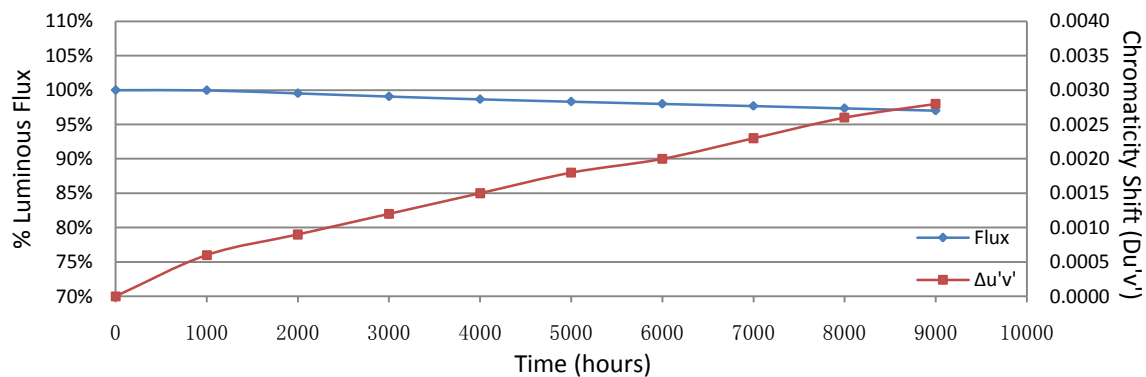
Test Duration: 9,000 hours
Failures Observed: 0
α: 3.359E-06
β: 1.000
Reported L₇₀: >54,000 hours

3.8 Data Set 3, 115° C, 120mA (Forward Voltage)

No.	Forward Voltage (V)									
	0hr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs
61	9.292	9.162	9.157	9.163	9.180	9.186	9.159	9.166	9.169	9.167
62	9.278	9.163	9.164	9.169	9.186	9.188	9.158	9.168	9.170	9.178
63	9.292	9.146	9.142	9.149	9.168	9.171	9.145	9.151	9.157	9.144
64	9.345	9.206	9.206	9.213	9.230	9.235	9.217	9.213	9.218	9.201
65	9.332	9.199	9.194	9.208	9.217	9.229	9.204	9.194	9.210	9.194
66	9.292	9.149	9.154	9.161	9.174	9.179	9.157	9.148	9.155	9.148
67	9.337	9.203	9.206	9.206	9.226	9.229	9.202	9.205	9.209	9.202
68	9.274	9.151	9.155	9.155	9.178	9.177	9.160	9.154	9.158	9.152
69	9.278	9.158	9.160	9.166	9.175	9.178	9.160	9.159	9.163	9.159
70	9.279	9.157	9.164	9.165	9.184	9.186	9.280	9.164	9.169	9.169
71	9.332	9.184	9.191	9.190	9.203	9.211	9.198	9.187	9.195	9.189
72	9.378	9.229	9.224	9.231	9.242	9.249	9.241	9.229	9.240	9.228
73	9.277	9.119	9.116	9.124	9.140	9.142	9.153	9.127	9.128	9.122
74	9.386	9.229	9.230	9.230	9.248	9.252	9.234	9.229	9.238	9.224
75	9.318	9.164	9.172	9.178	9.183	9.193	9.169	9.174	9.173	9.167
76	9.241	9.098	9.103	9.104	9.114	9.116	9.100	9.101	9.111	9.095
77	9.382	9.231	9.241	9.246	9.253	9.260	9.237	9.241	9.249	9.233
78	9.321	9.191	9.194	9.193	9.204	9.207	9.190	9.195	9.200	9.188
79	9.260	9.123	9.132	9.132	9.144	9.152	9.128	9.126	9.130	9.123
80	9.270	9.135	9.140	9.151	9.157	9.166	9.147	9.140	9.148	9.131
81	9.323	9.182	9.188	9.192	9.203	9.205	9.184	9.186	9.188	9.180
82	9.264	9.120	9.118	9.128	9.140	9.136	9.123	9.122	9.127	9.117
83	9.322	9.164	9.163	9.172	9.181	9.180	9.166	9.173	9.169	9.170
84	9.361	9.223	9.227	9.238	9.241	9.251	9.231	9.229	9.246	9.227
85	9.302	9.168	9.170	9.180	9.188	9.194	9.173	9.192	9.185	9.166
86	9.342	9.217	9.225	9.225	9.244	9.243	9.221	9.228	9.235	9.221
87	9.269	9.149	9.152	9.162	9.171	9.177	9.150	9.158	9.162	9.144
88	9.311	9.200	9.201	9.208	9.217	9.223	9.203	9.207	9.204	9.190
89	9.321	9.211	9.212	9.220	9.233	9.235	9.215	9.210	9.218	9.208
90	9.332	9.206	9.203	9.214	9.228	9.223	9.209	9.214	9.224	9.198
Ave.	9.310	9.175	9.177	9.182	9.195	9.199	9.184	9.180	9.185	9.175
Med.	9.315	9.166	9.171	9.179	9.187	9.194	9.179	9.180	9.179	9.174
st dev	0.0382	0.0367	0.0368	0.0367	0.0365	0.0373	0.0407	0.0369	0.0384	0.0363
Min.	9.241	9.098	9.103	9.104	9.114	9.116	9.100	9.101	9.111	9.095
Max.	9.386	9.231	9.241	9.246	9.253	9.260	9.280	9.241	9.249	9.233

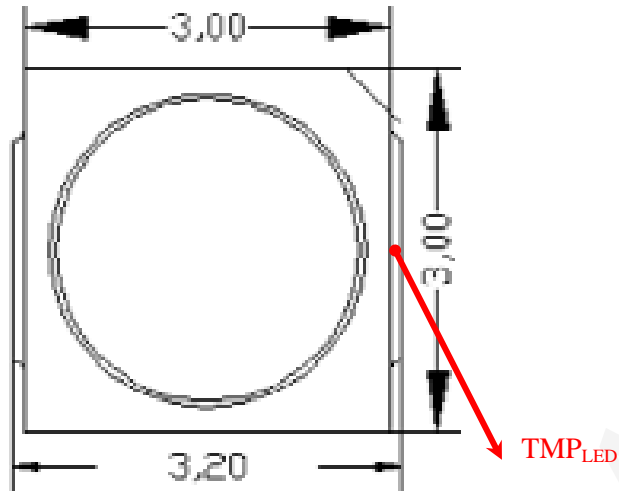
3.9 Data Set 3, 115° C, 120mA (Chromaticity Shift)

No.	u'	v'	CCT(K)	Chromaticity Shift ($\Delta u'v'$)								
	0hr(Initial)			1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs
61	0.2573	0.5273	2812	0.0006	0.0009	0.0013	0.0015	0.0017	0.0020	0.0023	0.0026	0.0029
62	0.2589	0.5295	2766	0.0006	0.0009	0.0012	0.0015	0.0017	0.0021	0.0023	0.0026	0.0028
63	0.2605	0.5292	2734	0.0006	0.0009	0.0013	0.0016	0.0018	0.0021	0.0024	0.0028	0.0030
64	0.2598	0.5293	2747	0.0006	0.0009	0.0013	0.0015	0.0018	0.0021	0.0024	0.0026	0.0027
65	0.2576	0.5265	2808	0.0006	0.0010	0.0013	0.0016	0.0019	0.0022	0.0025	0.0030	0.0034
66	0.2591	0.5262	2778	0.0006	0.0009	0.0013	0.0015	0.0018	0.0021	0.0024	0.0027	0.0028
67	0.2575	0.5264	2811	0.0006	0.0009	0.0012	0.0014	0.0017	0.0020	0.0023	0.0026	0.0027
68	0.2601	0.5302	2738	0.0006	0.0009	0.0011	0.0014	0.0017	0.0021	0.0023	0.0027	0.0028
69	0.2566	0.5278	2824	0.0004	0.0008	0.0011	0.0014	0.0016	0.0019	0.0022	0.0026	0.0027
70	0.2610	0.5298	2722	0.0006	0.0009	0.0012	0.0014	0.0017	0.0020	0.0023	0.0026	0.0028
71	0.2574	0.5279	2806	0.0006	0.0009	0.0013	0.0014	0.0017	0.0020	0.0022	0.0026	0.0028
72	0.2600	0.5302	2741	0.0006	0.0009	0.0012	0.0015	0.0017	0.0019	0.0022	0.0025	0.0027
73	0.2580	0.5271	2797	0.0006	0.0009	0.0011	0.0015	0.0017	0.0020	0.0022	0.0026	0.0028
74	0.2579	0.5296	2788	0.0006	0.0009	0.0013	0.0015	0.0017	0.0020	0.0023	0.0025	0.0028
75	0.2581	0.5289	2786	0.0006	0.0009	0.0013	0.0015	0.0018	0.0021	0.0023	0.0026	0.0028
76	0.2570	0.5263	2823	0.0006	0.0009	0.0013	0.0015	0.0017	0.0020	0.0023	0.0026	0.0028
77	0.2588	0.5296	2769	0.0007	0.0009	0.0012	0.0014	0.0017	0.0020	0.0023	0.0025	0.0027
78	0.2565	0.5276	2827	0.0007	0.0009	0.0012	0.0015	0.0017	0.0021	0.0024	0.0026	0.0028
79	0.2602	0.5288	2743	0.0006	0.0009	0.0013	0.0015	0.0019	0.0021	0.0024	0.0027	0.0028
80	0.2576	0.5297	2793	0.0006	0.0009	0.0012	0.0014	0.0017	0.0020	0.0022	0.0026	0.0027
81	0.2588	0.5301	2765	0.0006	0.0009	0.0011	0.0015	0.0017	0.0019	0.0022	0.0026	0.0028
82	0.2564	0.5281	2828	0.0007	0.0009	0.0013	0.0015	0.0018	0.0021	0.0024	0.0027	0.0028
83	0.2583	0.5281	2784	0.0006	0.0008	0.0011	0.0014	0.0017	0.0019	0.0022	0.0026	0.0027
84	0.2590	0.5298	2764	0.0006	0.0009	0.0013	0.0015	0.0019	0.0021	0.0024	0.0026	0.0028
85	0.2589	0.5289	2769	0.0007	0.0009	0.0013	0.0015	0.0019	0.0021	0.0024	0.0026	0.0028
86	0.2605	0.5308	2728	0.0006	0.0009	0.0013	0.0015	0.0018	0.0021	0.0024	0.0026	0.0029
87	0.2580	0.5278	2793	0.0006	0.0009	0.0012	0.0014	0.0017	0.0021	0.0023	0.0027	0.0030
88	0.2601	0.5282	2747	0.0007	0.0010	0.0013	0.0016	0.0019	0.0022	0.0025	0.0029	0.0032
89	0.2574	0.5278	2807	0.0006	0.0009	0.0012	0.0015	0.0017	0.0021	0.0023	0.0028	0.0032
90	0.2568	0.5271	2823	0.0006	0.0009	0.0012	0.0014	0.0017	0.0021	0.0024	0.0026	0.0030
Ave.	0.2585	0.5285	2781	0.0006	0.0009	0.0012	0.0015	0.0018	0.0020	0.0023	0.0026	0.0028
Med.	0.2582	0.5285	2785	0.0006	0.0009	0.0013	0.0015	0.0017	0.0021	0.0023	0.0026	0.0028
st dev	0.0013	0.0013	32.6889	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002
Min.	0.2564	0.5262	2722	0.0004	0.0008	0.0011	0.0014	0.0016	0.0019	0.0022	0.0025	0.0027
Max.	0.2610	0.5308	2828	0.0007	0.0010	0.0013	0.0016	0.0019	0.0022	0.0025	0.0030	0.0034



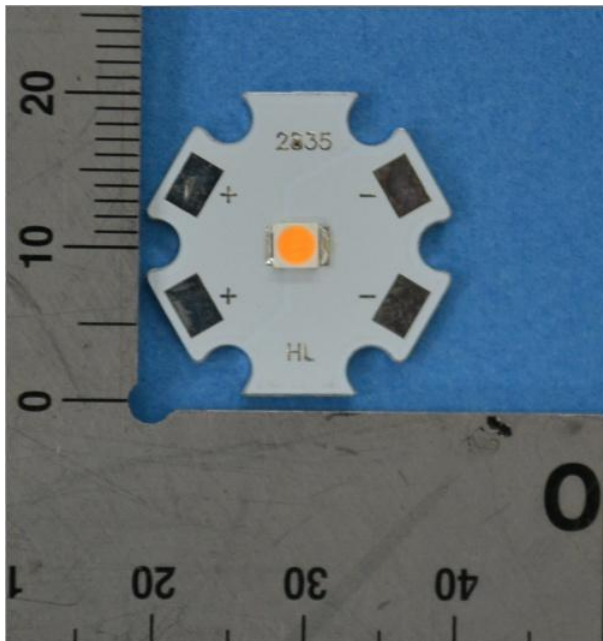
4 - EUT Photo

4.1 Mechanical Dimensions



All dimensions are in millimeter

4.2 EUT Photo



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