



TEST REPORT

According to ANSI/IES LM-80-15
For

Lumileds Holding B.V.

370 W. Trimble Road, San Jose, CA 95131, USA

Model: L128-2790RC35002J1

Report Type: 17000 Hours Test Report	Product Type: LED Package
Reviewed By:	Pote Wang <i>Pote Wang</i>
Report Number:	2402W63259E-EE
Test Date:	2022-09-02 to 2024-08-14
Report Date:	2024-08-26
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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 2022-09-02. The samples were numbered from 1 to 25 and 26 to 50.

Manufacturer:	Lumileds Holding B.V.
Part Number:	L128-2790RC35002J1
Part Type:	LED Package
Drive Level:	DC 120mA
Nominal CCT:	2700K
Power:	1.2W
Average Current Density per LED die:	826.668mA/mm ²
Average Power Density per LED die:	2.756W/mm ²
CRI:	90
Die Spacing:	0.15mm

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.

Note:

1. The applicant Lumileds Holding B.V. declare that their products with model L128-2790RC35002J1 are the same to the products in report # 2202X45920-EE-17000 and is authorized by original applicant to use their test data.
2. All the data in previous report (2202X45920-EE-17000) is shared in this report.

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 ²)	Current density per LED die (mA/mm ²)	Current per die(mA)	Distance between of dies (mm)	Current (mA)
Test model	L128-2790RC35002J1	90	2700K	3	1	0.118	826.668	120	0.15	120
multiple model	L128-****RC3500***	80-90	2200K-6500K	3	1	0.118	826.668	120	0.15	120
multiple model	L128-****RA3500***	80-90	2200K-6500K	1	3	0.118	826.668	100	0.15	300
multiple model	L128-****RB3500***	80-90	2200K-6500K	2	1	0.118	826.668	150	0.15	150
multiple model	L128-****RA3500***	80-90	2200K-6500K	1	2	0.118	826.668	150	0.15	300
multiple model	L128-****RA3500***	80-90	2200K-6500K	1	1	0.118	826.668	300	/	300

Note:

The model name begins with such as "L128-****RC3500****", "*" is described in detail as follows :

1. The first and second * designates nominal CCT (22=2200K,23=2300K,24=2400K,25=2500K,27=2700K,30=3000K, 35=3500K,40=4000K,45=4500K, 50=5000K, 57=5700K, 60=6000K, 65=6500K);
2. The third and fourth * designates the different product solution (Color coordinate and applications and special solution etc.);
3. The last three * designates Lumileds internal codes (0A1, 0B1, 0C1, etc.=shares the same base).

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/CCD Spectrometer	Hangzhouyuming	0.5m /SPM-5000	C612012A	2023-09-02	2024-09-01
CC&CV DC Power Supply	Hangzhouyuming	DPS-500	W412022M	2023-09-02	2024-09-01
Standard Light Source	EVERFINE	D062	M133799CM1381112	2023-05-12	2025-05-11
Multilayer aging machine	BACL	B2-270	20022	2023-10-16	2024-10-15
Digital CC&CV DC Power Supply	EVERFINE	WY5015	11090008	2023-09-02	2024-09-01

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°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 $\pm 3\%$ 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. 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 $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$, 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 $U=21\text{K}$ ($K=2$), 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: 55°C, 120mA

Part Number: L128-2790RC35002J1

Number of Units: 25

Case Temperature: >53°C

Ambient Temperature: >50°C

Life Test Drive Current: 120mA

Measurement Current: 120mA

Data Set 2: 105°C, 120mA

Part Number: L128-2790RC35002J1

Number of Units: 25

Case Temperature: >103°C

Ambient Temperature: >100°C

Life Test Drive Current: 120mA

Measurement Current: 120mA

2 - Summary of Test Result

Data Set:	Sample Size	Failures Observed:	Test Interval	Test Duration	α	β	Reported TM-21 L ₇₀ Lifetime	Reported TM-21 L ₉₀ Lifetime
1	25	0	1000hrs	17000hrs	1.673E-06	1.005	>102000 hours	66000 hours
2	25	0	1000hrs	17000hrs	1.788E-06	1.001	>102000 hours	60000 hours

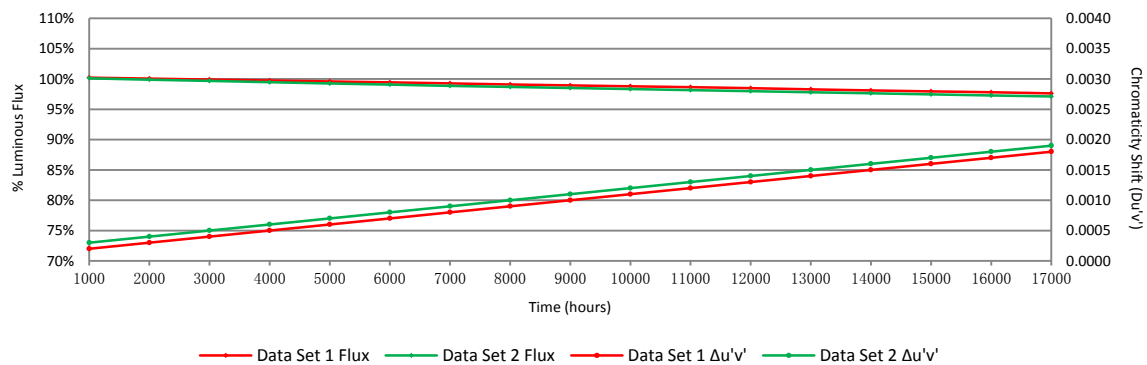
Average Lumen Maintenance (Percentage of Initial Luminous Flux)

Data Set:	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs	10000hrs
1	100.22%	100.06%	99.90%	99.75%	99.59%	99.44%	99.27%	99.09%	98.94%	98.79%
2	100.11%	99.88%	99.68%	99.47%	99.26%	99.07%	98.86%	98.69%	98.51%	98.34%
	11000hrs	12000hrs	13000hrs	14000hrs	15000hrs	16000hrs	17000hrs			
	98.65%	98.48%	98.29%	98.11%	97.95%	97.81%	97.62%			
	98.16%	97.99%	97.81%	97.64%	97.46%	97.28%	97.12%			

Average Chromaticity Shift

Data Set:	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs	10000hrs
1	0.0002	0.0003	0.0004	0.0005	0.0006	0.0007	0.0008	0.0009	0.0010	0.0011
2	0.0003	0.0004	0.0005	0.0006	0.0007	0.0008	0.0009	0.0010	0.0011	0.0012
	11000hrs	12000hrs	13000hrs	14000hrs	15000hrs	16000hrs	17000hrs			
	0.0012	0.0013	0.0014	0.0015	0.0016	0.0017	0.0018			
	0.0013	0.0014	0.0015	0.0016	0.0017	0.0018	0.0019			

Average Lumen Maintenance and Chromaticity Shift VS. Time



3 - Test Data

3.1 Data Set 1, 55°C, 120mA (Lumen Maintenance)

No.	Φ(lm)	Lumen Maintenance (%)									
	0hr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs	10000hrs
1	136.60	100.15	99.93	99.71	99.56	99.49	99.34	99.19	98.98	98.68	98.61
2	134.50	100.22	100.07	99.85	99.63	99.48	99.26	99.11	98.88	98.81	98.51
3	133.60	100.15	99.93	99.85	99.70	99.63	99.55	99.40	99.25	99.18	99.10
4	134.80	100.15	99.93	99.85	99.63	99.33	99.11	98.81	98.59	98.29	98.07
5	133.50	100.30	100.07	99.85	99.78	99.48	99.25	99.10	98.88	98.58	98.28
6	134.40	100.15	100.07	99.93	99.85	99.70	99.55	99.48	99.33	99.26	99.18
7	134.60	100.15	99.93	99.85	99.70	99.33	99.11	98.89	98.66	98.51	98.44
8	132.80	100.23	100.08	99.70	99.47	99.10	98.95	98.72	98.57	98.49	98.34
9	133.40	100.15	99.93	99.70	99.48	99.33	99.18	99.10	99.03	98.65	98.50
10	135.60	100.22	100.15	100.07	99.93	99.78	99.71	99.63	99.56	99.41	99.26
11	132.40	100.15	100.08	99.92	99.70	99.55	99.47	99.32	99.17	98.94	98.79
12	133.70	100.15	99.93	99.55	99.33	99.25	99.10	98.88	98.65	98.35	98.28
13	134.00	100.15	100.07	99.93	99.85	99.70	99.63	99.55	99.40	99.25	99.10
14	133.90	100.22	100.15	100.07	99.93	99.85	99.78	99.70	99.48	99.40	99.03
15	133.70	100.22	100.07	99.93	99.85	99.78	99.63	99.48	99.25	99.18	99.10
16	136.10	100.22	100.07	99.85	99.71	99.49	99.41	99.19	98.90	98.60	98.31
17	135.00	100.22	100.07	99.93	99.85	99.56	99.48	99.33	99.11	99.04	98.89
18	134.10	100.22	99.93	99.85	99.70	99.55	99.40	99.25	99.03	98.96	98.88
19	133.50	100.30	100.22	99.85	99.78	99.63	99.40	99.18	99.03	98.88	98.65
20	133.90	100.37	100.30	100.22	100.15	100.07	99.93	99.78	99.63	99.55	99.48
21	134.30	100.45	100.22	100.07	99.93	99.85	99.78	99.63	99.48	99.40	99.33
22	135.10	100.37	100.07	100.00	99.93	99.78	99.63	99.41	99.26	99.19	99.04
23	133.50	100.22	100.07	99.93	99.70	99.63	99.25	99.10	98.88	98.73	98.58
24	134.30	100.22	99.93	99.85	99.63	99.48	99.26	98.96	98.81	98.73	98.59
25	133.90	100.22	100.15	100.07	99.93	99.85	99.78	99.63	99.55	99.40	99.33
Avg.	134.21	100.22	100.06	99.90	99.75	99.59	99.44	99.27	99.09	98.94	98.79
Med.	134.00	100.22	100.07	99.85	99.71	99.56	99.41	99.25	99.03	98.94	98.79
st dev	0.96	0.08	0.11	0.14	0.18	0.22	0.26	0.29	0.32	0.37	0.40
Min.	132.40	100.15	99.93	99.55	99.33	99.10	98.95	98.72	98.57	98.29	98.07
Max.	136.60	100.45	100.30	100.22	100.15	100.07	99.93	99.78	99.63	99.55	99.48

No.	Lumen Maintenance (%)						
	11000hrs	12000hrs	13000hrs	14000hrs	15000hrs	16000hrs	17000hrs
1	98.54	98.46	98.32	98.17	98.10	97.95	97.80
2	98.29	98.07	97.77	97.55	97.40	97.25	97.17
3	99.03	98.95	98.73	98.50	98.35	98.13	97.83
4	97.85	97.70	97.48	97.40	97.18	96.96	96.88
5	98.05	97.83	97.53	97.38	97.23	97.00	96.78
6	99.11	98.96	98.74	98.36	98.21	98.07	97.84
7	98.14	97.92	97.62	97.25	97.03	96.95	96.66
8	98.19	98.04	97.89	97.74	97.59	97.52	97.29
9	98.35	98.13	97.98	97.68	97.38	97.23	97.00
10	99.19	98.82	98.60	98.45	98.38	98.23	97.94
11	98.64	98.56	98.34	98.19	98.04	97.96	97.81
12	98.13	97.98	97.76	97.68	97.61	97.46	97.31
13	98.96	98.81	98.66	98.51	98.36	98.21	98.13
14	98.88	98.81	98.66	98.58	98.36	98.21	97.98
15	99.03	98.80	98.73	98.65	98.43	98.20	97.98
16	98.16	97.87	97.80	97.65	97.43	97.21	97.13
17	98.81	98.67	98.44	98.30	98.15	98.00	97.78
18	98.81	98.73	98.66	98.43	98.36	98.21	98.14
19	98.43	98.28	98.13	97.90	97.75	97.68	97.45
20	99.33	99.18	99.03	98.81	98.58	98.36	98.28
21	99.18	99.03	98.73	98.59	98.36	98.29	98.06
22	98.96	98.89	98.74	98.59	98.45	98.30	98.15
23	98.43	98.13	97.90	97.75	97.68	97.60	97.38
24	98.51	98.36	98.14	97.99	97.92	97.84	97.54
25	99.18	99.03	98.88	98.58	98.43	98.36	98.21
Avg.	98.65	98.48	98.29	98.11	97.95	97.81	97.62
Med.	98.64	98.56	98.34	98.19	98.10	97.96	97.80
st dev	0.43	0.45	0.47	0.47	0.48	0.48	0.48
Min.	97.85	97.70	97.48	97.25	97.03	96.95	96.66
Max.	99.33	99.18	99.03	98.81	98.58	98.36	98.28

3.2 Data Set 1, 55°C, 120mA (Forward Voltage)

No.	Forward Voltage (V)										
	Ohr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs	10000hrs
1	9.176	9.178	9.174	9.173	9.174	9.171	9.179	9.177	9.177	9.176	9.176
2	9.231	9.236	9.236	9.226	9.226	9.223	9.235	9.228	9.228	9.227	9.228
3	9.200	9.208	9.202	9.195	9.195	9.192	9.204	9.195	9.197	9.196	9.195
4	9.248	9.252	9.250	9.242	9.242	9.238	9.255	9.244	9.244	9.244	9.244
5	9.212	9.213	9.210	9.204	9.206	9.199	9.216	9.207	9.211	9.205	9.209
6	9.257	9.266	9.257	9.249	9.249	9.243	9.255	9.254	9.256	9.251	9.254
7	9.237	9.248	9.244	9.238	9.238	9.232	9.242	9.243	9.247	9.238	9.243
8	9.253	9.266	9.264	9.256	9.256	9.251	9.260	9.261	9.263	9.256	9.257
9	9.232	9.238	9.238	9.229	9.232	9.226	9.238	9.236	9.238	9.231	9.233
10	9.188	9.203	9.202	9.193	9.194	9.190	9.205	9.199	9.201	9.195	9.198
11	9.225	9.230	9.233	9.222	9.223	9.222	9.233	9.226	9.228	9.223	9.229
12	9.236	9.247	9.250	9.242	9.242	9.235	9.254	9.247	9.247	9.242	9.253
13	9.222	9.235	9.235	9.227	9.225	9.220	9.239	9.231	9.231	9.226	9.233
14	9.174	9.186	9.189	9.177	9.177	9.172	9.186	9.183	9.181	9.175	9.183
15	9.186	9.196	9.199	9.189	9.187	9.182	9.201	9.191	9.193	9.186	9.198
16	9.201	9.211	9.213	9.208	9.204	9.197	9.215	9.207	9.210	9.206	9.213
17	9.197	9.210	9.212	9.205	9.210	9.196	9.211	9.208	9.210	9.203	9.213
18	9.180	9.192	9.196	9.187	9.192	9.180	9.195	9.192	9.199	9.186	9.190
19	9.189	9.201	9.203	9.195	9.202	9.188	9.203	9.199	9.206	9.196	9.198
20	9.202	9.221	9.217	9.207	9.218	9.199	9.219	9.213	9.218	9.209	9.210
21	9.187	9.206	9.203	9.195	9.203	9.189	9.209	9.199	9.204	9.196	9.198
22	9.201	9.219	9.217	9.209	9.214	9.205	9.223	9.213	9.217	9.208	9.213
23	9.175	9.185	9.182	9.172	9.178	9.166	9.196	9.178	9.182	9.175	9.177
24	9.232	9.242	9.240	9.232	9.240	9.225	9.246	9.238	9.239	9.232	9.233
25	9.217	9.235	9.230	9.222	9.226	9.216	9.236	9.228	9.228	9.223	9.224
Avg.	9.210	9.221	9.220	9.212	9.214	9.206	9.222	9.216	9.218	9.212	9.216
Med.	9.202	9.219	9.217	9.208	9.214	9.199	9.219	9.213	9.217	9.208	9.213
st dev	0.026	0.025	0.024	0.024	0.024	0.024	0.023	0.024	0.024	0.024	0.024
Min.	9.174	9.178	9.174	9.172	9.174	9.166	9.179	9.177	9.177	9.175	9.176
Max.	9.257	9.266	9.264	9.256	9.256	9.251	9.260	9.261	9.263	9.256	9.257

No.	Forward Voltage (V)						
	11000hrs	12000hrs	13000hrs	14000hrs	15000hrs	16000hrs	17000hrs
1	9.172	9.181	9.184	9.177	9.178	9.179	9.177
2	9.225	9.234	9.233	9.232	9.228	9.231	9.228
3	9.193	9.235	9.206	9.196	9.196	9.199	9.201
4	9.239	9.251	9.249	9.243	9.239	9.248	9.244
5	9.204	9.214	9.211	9.210	9.210	9.215	9.208
6	9.249	9.259	9.260	9.256	9.253	9.252	9.251
7	9.236	9.252	9.250	9.241	9.242	9.248	9.244
8	9.255	9.271	9.268	9.263	9.259	9.263	9.260
9	9.232	9.241	9.238	9.236	9.232	9.238	9.236
10	9.199	9.205	9.204	9.203	9.194	9.201	9.204
11	9.229	9.237	9.233	9.232	9.229	9.228	9.232
12	9.248	9.253	9.253	9.249	9.250	9.247	9.261
13	9.232	9.239	9.239	9.232	9.235	9.234	9.240
14	9.180	9.191	9.185	9.180	9.185	9.183	9.197
15	9.192	9.204	9.198	9.193	9.194	9.196	9.209
16	9.207	9.266	9.213	9.209	9.209	9.210	9.216
17	9.204	9.225	9.210	9.208	9.206	9.205	9.223
18	9.192	9.194	9.191	9.192	9.190	9.190	9.208
19	9.199	9.206	9.205	9.203	9.201	9.201	9.210
20	9.216	9.217	9.219	9.216	9.211	9.212	9.220
21	9.204	9.202	9.202	9.198	9.198	9.198	9.209
22	9.220	9.216	9.229	9.211	9.211	9.212	9.218
23	9.183	9.178	9.187	9.174	9.175	9.176	9.185
24	9.239	9.241	9.244	9.240	9.237	9.235	9.244
25	9.228	9.229	9.231	9.228	9.228	9.226	9.231
Avg.	9.215	9.226	9.222	9.217	9.216	9.217	9.222
Med.	9.216	9.229	9.219	9.211	9.211	9.212	9.220
st dev	0.023	0.026	0.025	0.025	0.024	0.025	0.022
Min.	9.172	9.178	9.184	9.174	9.175	9.176	9.177
Max.	9.255	9.271	9.268	9.263	9.259	9.263	9.261

3.3 Data Set 1, 55°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	10000hrs
1	0.2585	0.5326	2761	0.0002	0.0004	0.0003	0.0006	0.0004	0.0008	0.0007	0.0007	0.0009	0.0010
2	0.2602	0.5317	2731	0.0002	0.0003	0.0005	0.0008	0.0008	0.0006	0.0009	0.0012	0.0014	0.0014
3	0.2607	0.5327	2716	0.0001	0.0003	0.0004	0.0006	0.0006	0.0005	0.0007	0.0010	0.0011	0.0013
4	0.2593	0.5321	2748	0.0001	0.0002	0.0003	0.0004	0.0006	0.0004	0.0005	0.0008	0.0010	0.0012
5	0.2620	0.5312	2695	0.0001	0.0002	0.0004	0.0004	0.0005	0.0005	0.0007	0.0007	0.0009	0.0012
6	0.2617	0.5331	2694	0.0001	0.0003	0.0004	0.0004	0.0005	0.0005	0.0008	0.0008	0.0011	0.0013
7	0.2591	0.5319	2751	0.0001	0.0002	0.0004	0.0005	0.0005	0.0005	0.0007	0.0007	0.0009	0.0010
8	0.2598	0.5310	2742	0.0002	0.0003	0.0003	0.0006	0.0006	0.0007	0.0009	0.0010	0.0012	0.0012
9	0.2599	0.5322	2733	0.0002	0.0003	0.0004	0.0004	0.0005	0.0008	0.0008	0.0008	0.0010	0.0009
10	0.2597	0.5320	2740	0.0002	0.0002	0.0003	0.0004	0.0006	0.0006	0.0007	0.0008	0.0011	0.0008
11	0.2613	0.5317	2708	0.0003	0.0002	0.0004	0.0005	0.0006	0.0008	0.0008	0.0008	0.0009	0.0011
12	0.2583	0.5315	2772	0.0003	0.0002	0.0004	0.0006	0.0006	0.0008	0.0008	0.0008	0.0009	0.0009
13	0.2593	0.5305	2754	0.0002	0.0004	0.0003	0.0005	0.0006	0.0009	0.0010	0.0010	0.0011	0.0011
14	0.2605	0.5326	2719	0.0002	0.0003	0.0006	0.0007	0.0007	0.0009	0.0010	0.0009	0.0009	0.0011
15	0.2598	0.5311	2741	0.0002	0.0004	0.0005	0.0007	0.0007	0.0009	0.0009	0.0010	0.0011	0.0011
16	0.2587	0.5332	2754	0.0002	0.0005	0.0005	0.0006	0.0006	0.0008	0.0010	0.0009	0.0010	0.0009
17	0.2601	0.5325	2729	0.0002	0.0005	0.0004	0.0005	0.0005	0.0008	0.0008	0.0008	0.0009	0.0010
18	0.2606	0.5307	2727	0.0003	0.0003	0.0003	0.0004	0.0006	0.0009	0.0010	0.0010	0.0012	0.0011
19	0.2612	0.5312	2712	0.0004	0.0004	0.0004	0.0006	0.0006	0.0008	0.0010	0.0010	0.0011	0.0012
20	0.2600	0.5320	2733	0.0002	0.0005	0.0004	0.0006	0.0006	0.0007	0.0009	0.0009	0.0012	0.0012
21	0.2589	0.5333	2750	0.0002	0.0005	0.0003	0.0004	0.0006	0.0007	0.0009	0.0008	0.0008	0.0009
22	0.2586	0.5307	2767	0.0002	0.0005	0.0004	0.0005	0.0006	0.0008	0.0009	0.0009	0.0010	0.0010
23	0.2614	0.5334	2698	0.0003	0.0004	0.0004	0.0006	0.0006	0.0008	0.0009	0.0008	0.0009	0.0010
24	0.2606	0.5329	2716	0.0004	0.0004	0.0004	0.0004	0.0006	0.0008	0.0009	0.0010	0.0010	0.0011
25	0.2623	0.5324	2685	0.0003	0.0003	0.0003	0.0006	0.0006	0.0008	0.0008	0.0009	0.0009	0.0010
Avg.	0.2601	0.5320	2731	0.0002	0.0003	0.0004	0.0005	0.0006	0.0007	0.0008	0.0009	0.0010	0.0011
Med.	0.2600	0.5320	2733	0.0002	0.0003	0.0004	0.0005	0.0006	0.0008	0.0009	0.0009	0.0010	0.0011
st dev	0.0011	0.0009	24	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0002
Min.	0.2583	0.5305	2685	0.0001	0.0002	0.0003	0.0004	0.0004	0.0004	0.0005	0.0007	0.0008	0.0008
Max.	0.2623	0.5334	2772	0.0004	0.0005	0.0006	0.0008	0.0008	0.0009	0.0010	0.0012	0.0014	0.0014

No.	Chromaticity Shift ($\Delta u'v'$)						
	11000hrs	12000hrs	13000hrs	14000hrs	15000hrs	16000hrs	17000hrs
1	0.0011	0.0014	0.0014	0.0016	0.0017	0.0016	0.0018
2	0.0012	0.0010	0.0016	0.0019	0.0019	0.0019	0.0021
3	0.0013	0.0010	0.0016	0.0016	0.0018	0.0019	0.0022
4	0.0012	0.0011	0.0011	0.0015	0.0016	0.0020	0.0015
5	0.0011	0.0012	0.0014	0.0017	0.0015	0.0019	0.0014
6	0.0014	0.0015	0.0014	0.0014	0.0016	0.0015	0.0016
7	0.0012	0.0011	0.0014	0.0014	0.0015	0.0008	0.0014
8	0.0009	0.0013	0.0015	0.0016	0.0017	0.0015	0.0016
9	0.0008	0.0012	0.0013	0.0015	0.0015	0.0018	0.0014
10	0.0008	0.0012	0.0013	0.0014	0.0014	0.0017	0.0018
11	0.0008	0.0016	0.0015	0.0015	0.0016	0.0018	0.0020
12	0.0012	0.0015	0.0013	0.0014	0.0015	0.0019	0.0019
13	0.0013	0.0016	0.0016	0.0016	0.0016	0.0020	0.0020
14	0.0012	0.0016	0.0015	0.0016	0.0016	0.0019	0.0020
15	0.0010	0.0013	0.0014	0.0016	0.0015	0.0018	0.0019
16	0.0011	0.0014	0.0013	0.0015	0.0015	0.0018	0.0019
17	0.0014	0.0014	0.0013	0.0015	0.0016	0.0020	0.0021
18	0.0015	0.0016	0.0015	0.0015	0.0017	0.0019	0.0020
19	0.0015	0.0016	0.0015	0.0016	0.0016	0.0019	0.0021
20	0.0014	0.0015	0.0015	0.0016	0.0016	0.0019	0.0020
21	0.0014	0.0015	0.0013	0.0014	0.0014	0.0017	0.0018
22	0.0015	0.0009	0.0014	0.0015	0.0014	0.0017	0.0019
23	0.0014	0.0009	0.0015	0.0014	0.0015	0.0018	0.0019
24	0.0014	0.0010	0.0015	0.0015	0.0019	0.0016	0.0018
25	0.0014	0.0009	0.0014	0.0015	0.0018	0.0015	0.0017
Avg.	0.0012	0.0013	0.0014	0.0015	0.0016	0.0017	0.0018
Med.	0.0012	0.0013	0.0014	0.0015	0.0016	0.0018	0.0019
st dev	0.0002	0.0002	0.0001	0.0001	0.0001	0.0002	0.0002
Min.	0.0008	0.0009	0.0011	0.0014	0.0014	0.0008	0.0014
Max.	0.0015	0.0016	0.0016	0.0019	0.0019	0.0020	0.0022

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

No.	Φ(lm)	Lumen Maintenance (%)									
	0hr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs	10000hrs
26	133.80	100.15	99.85	99.63	99.48	99.10	98.88	98.65	98.58	98.43	98.28
27	133.50	100.15	100.07	99.78	99.63	99.48	99.18	98.95	98.88	98.58	98.50
28	132.50	100.15	100.08	99.92	99.85	99.62	99.47	99.40	99.17	99.02	98.72
29	131.90	100.08	99.77	99.55	99.32	99.17	98.94	98.79	98.71	98.56	98.33
30	136.00	100.22	100.07	99.85	99.78	99.71	99.56	99.49	99.26	99.04	98.75
31	134.20	100.15	100.07	99.70	99.40	99.25	99.03	98.81	98.51	98.29	98.14
32	135.00	100.07	99.93	99.70	99.41	99.11	98.89	98.67	98.44	98.30	98.22
33	132.10	100.08	99.92	99.77	99.39	99.24	98.94	98.71	98.49	98.41	98.26
34	135.80	100.15	99.85	99.63	99.48	99.41	99.26	99.12	98.90	98.67	98.53
35	135.70	100.22	99.85	99.63	99.19	99.12	98.82	98.45	98.31	98.23	97.94
36	132.70	100.08	99.70	99.47	99.32	98.87	98.57	98.34	98.12	97.97	97.81
37	133.70	100.15	99.70	99.63	99.25	99.10	99.03	98.95	98.88	98.73	98.58
38	134.50	100.07	99.78	99.70	99.48	99.33	99.26	99.18	98.96	98.74	98.66
39	134.20	100.15	99.85	99.55	99.40	99.11	98.88	98.51	98.36	98.29	98.21
40	136.60	100.15	99.93	99.85	99.71	99.56	99.34	99.19	99.05	98.83	98.68
41	135.30	100.15	99.85	99.63	99.41	99.19	99.04	98.82	98.74	98.67	98.52
42	133.40	100.07	99.85	99.70	99.33	98.95	98.65	98.50	98.28	98.05	97.83
43	132.10	100.15	99.77	99.62	99.39	99.24	99.17	99.02	98.94	98.79	98.71
44	134.60	100.07	99.93	99.78	99.55	99.26	98.96	98.66	98.51	98.37	98.07
45	132.50	100.08	99.92	99.77	99.40	99.17	98.94	98.64	98.49	98.04	97.89
46	133.30	100.15	100.08	99.92	99.77	99.62	99.47	99.40	99.25	99.02	98.87
47	134.40	100.07	99.93	99.55	99.48	99.18	98.96	98.81	98.36	98.07	97.92
48	133.00	100.08	99.92	99.62	99.55	99.25	99.10	98.57	98.35	98.27	98.12
49	134.50	100.07	99.85	99.55	99.41	99.26	99.18	99.03	98.88	98.66	98.51
50	133.20	99.92	99.55	99.47	99.40	99.32	99.17	98.95	98.80	98.72	98.35
Avg.	133.94	100.11	99.88	99.68	99.47	99.26	99.07	98.86	98.69	98.51	98.34
Med.	133.80	100.15	99.85	99.63	99.41	99.24	99.03	98.81	98.71	98.56	98.33
st dev	1.31	0.06	0.13	0.13	0.17	0.21	0.24	0.31	0.32	0.32	0.32
Min.	131.90	99.92	99.55	99.47	99.19	98.87	98.57	98.34	98.12	97.97	97.81
Max.	136.60	100.22	100.08	99.92	99.85	99.71	99.56	99.49	99.26	99.04	98.87

No.	Lumen Maintenance (%)						
	11000hrs	12000hrs	13000hrs	14000hrs	15000hrs	16000hrs	17000hrs
26	98.21	98.06	97.91	97.68	97.31	97.01	96.86
27	98.35	98.28	97.98	97.75	97.53	97.38	97.15
28	98.57	98.19	97.96	97.81	97.58	97.36	97.06
29	98.26	98.18	98.03	97.88	97.57	97.27	97.04
30	98.60	98.31	98.09	98.01	97.94	97.87	97.79
31	97.99	97.76	97.62	97.39	97.24	97.02	96.87
32	98.00	97.78	97.56	97.41	97.19	97.04	96.81
33	98.11	97.96	97.88	97.65	97.58	97.35	97.27
34	98.38	98.31	97.94	97.72	97.57	97.42	97.20
35	97.72	97.27	97.20	97.13	96.98	96.76	96.54
36	97.44	97.21	97.06	96.99	96.91	96.83	96.76
37	98.43	98.35	98.13	97.98	97.76	97.61	97.38
38	98.44	98.36	98.14	97.92	97.84	97.62	97.40
39	98.06	97.91	97.84	97.76	97.69	97.62	97.54
40	98.46	98.24	98.10	97.95	97.88	97.80	97.73
41	98.37	98.30	98.15	98.00	97.93	97.78	97.71
42	97.75	97.60	97.30	97.15	96.93	96.70	96.55
43	98.56	98.41	98.18	97.96	97.80	97.65	97.58
44	97.85	97.77	97.70	97.47	97.33	97.10	96.95
45	97.81	97.66	97.51	97.36	97.13	97.06	96.83
46	98.72	98.42	98.27	98.05	97.75	97.52	97.30
47	97.77	97.62	97.47	97.25	96.95	96.80	96.73
48	97.89	97.74	97.59	97.44	97.29	97.07	96.99
49	98.44	98.22	98.14	97.99	97.84	97.62	97.40
50	97.90	97.75	97.60	97.37	97.00	96.85	96.62
Avg.	98.16	97.99	97.81	97.64	97.46	97.28	97.12
Med.	98.21	98.06	97.91	97.72	97.57	97.35	97.06
st dev	0.34	0.35	0.33	0.32	0.35	0.36	0.38
Min.	97.44	97.21	97.06	96.99	96.91	96.70	96.54
Max.	98.72	98.42	98.27	98.05	97.94	97.87	97.79

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	10000hrs
26	9.182	9.198	9.199	9.192	9.195	9.184	9.201	9.196	9.198	9.191	9.192
27	9.229	9.245	9.243	9.238	9.240	9.229	9.249	9.241	9.240	9.235	9.242
28	9.225	9.238	9.235	9.227	9.229	9.219	9.235	9.233	9.232	9.226	9.229
29	9.215	9.235	9.226	9.221	9.223	9.213	9.230	9.229	9.225	9.222	9.226
30	9.262	9.263	9.253	9.250	9.253	9.241	9.260	9.257	9.252	9.251	9.254
31	9.238	9.249	9.236	9.236	9.236	9.227	9.241	9.242	9.238	9.237	9.235
32	9.185	9.193	9.183	9.181	9.186	9.176	9.188	9.186	9.183	9.181	9.181
33	9.295	9.289	9.278	9.272	9.281	9.272	9.284	9.281	9.280	9.275	9.277
34	9.210	9.205	9.195	9.193	9.198	9.192	9.204	9.200	9.197	9.195	9.193
35	9.262	9.253	9.242	9.241	9.244	9.244	9.255	9.249	9.242	9.243	9.244
36	9.261	9.249	9.237	9.236	9.238	9.229	9.248	9.244	9.233	9.236	9.236
37	9.237	9.226	9.214	9.221	9.213	9.208	9.225	9.222	9.212	9.217	9.215
38	9.246	9.251	9.242	9.244	9.242	9.236	9.257	9.253	9.240	9.244	9.240
39	9.264	9.249	9.236	9.242	9.238	9.228	9.246	9.248	9.235	9.241	9.237
40	9.228	9.193	9.184	9.187	9.184	9.177	9.194	9.193	9.187	9.186	9.184
41	9.208	9.191	9.182	9.186	9.185	9.172	9.190	9.193	9.187	9.187	9.184
42	9.270	9.256	9.246	9.253	9.247	9.240	9.253	9.259	9.249	9.250	9.247
43	9.252	9.234	9.228	9.232	9.229	9.224	9.238	9.239	9.232	9.231	9.231
44	9.182	9.176	9.171	9.178	9.169	9.166	9.181	9.180	9.175	9.174	9.174
45	9.279	9.247	9.241	9.248	9.239	9.235	9.250	9.248	9.245	9.242	9.247
46	9.253	9.230	9.224	9.228	9.220	9.233	9.234	9.233	9.231	9.227	9.235
47	9.260	9.251	9.247	9.253	9.245	9.256	9.256	9.253	9.253	9.249	9.259
48	9.283	9.273	9.265	9.269	9.263	9.272	9.270	9.268	9.270	9.263	9.274
49	9.224	9.225	9.217	9.222	9.217	9.225	9.225	9.223	9.225	9.219	9.226
50	9.213	9.204	9.197	9.202	9.196	9.207	9.202	9.209	9.204	9.201	9.205
Avg.	9.239	9.233	9.225	9.226	9.224	9.220	9.233	9.231	9.227	9.225	9.227
Med.	9.238	9.238	9.235	9.232	9.229	9.227	9.238	9.239	9.232	9.231	9.235
st dev	0.031	0.029	0.028	0.027	0.028	0.029	0.028	0.027	0.027	0.027	0.029
Min.	9.182	9.176	9.171	9.178	9.169	9.166	9.181	9.180	9.175	9.174	9.174
Max.	9.295	9.289	9.278	9.272	9.281	9.272	9.284	9.281	9.280	9.275	9.277

No.	Forward Voltage (V)						
	11000hrs	12000hrs	13000hrs	14000hrs	15000hrs	16000hrs	17000hrs
26	9.195	9.196	9.200	9.195	9.193	9.193	9.208
27	9.242	9.244	9.255	9.242	9.239	9.241	9.253
28	9.232	9.234	9.241	9.224	9.234	9.232	9.242
29	9.226	9.230	9.238	9.222	9.230	9.228	9.248
30	9.258	9.259	9.255	9.256	9.263	9.257	9.280
31	9.240	9.238	9.242	9.237	9.247	9.239	9.259
32	9.183	9.187	9.183	9.184	9.192	9.186	9.212
33	9.279	9.285	9.278	9.281	9.283	9.283	9.291
34	9.204	9.202	9.198	9.201	9.199	9.201	9.224
35	9.247	9.250	9.244	9.247	9.250	9.250	9.265
36	9.241	9.241	9.236	9.238	9.248	9.242	9.254
37	9.222	9.222	9.215	9.218	9.227	9.220	9.229
38	9.247	9.246	9.240	9.245	9.256	9.250	9.254
39	9.250	9.242	9.238	9.241	9.247	9.242	9.251
40	9.196	9.190	9.186	9.190	9.195	9.193	9.201
41	9.195	9.194	9.187	9.188	9.201	9.190	9.195
42	9.256	9.254	9.248	9.252	9.254	9.252	9.262
43	9.236	9.236	9.228	9.236	9.238	9.233	9.244
44	9.178	9.181	9.171	9.180	9.180	9.174	9.180
45	9.248	9.245	9.241	9.247	9.247	9.241	9.255
46	9.232	9.230	9.226	9.231	9.235	9.229	9.238
47	9.257	9.256	9.248	9.254	9.259	9.251	9.259
48	9.271	9.268	9.268	9.272	9.271	9.259	9.271
49	9.225	9.225	9.221	9.233	9.224	9.216	9.225
50	9.205	9.204	9.204	9.214	9.204	9.197	9.210
Avg.	9.231	9.230	9.228	9.229	9.233	9.228	9.240
Med.	9.236	9.236	9.238	9.236	9.238	9.233	9.248
st dev	0.027	0.027	0.028	0.027	0.028	0.028	0.028
Min.	9.178	9.181	9.171	9.180	9.180	9.174	9.180
Max.	9.279	9.285	9.278	9.281	9.283	9.283	9.291

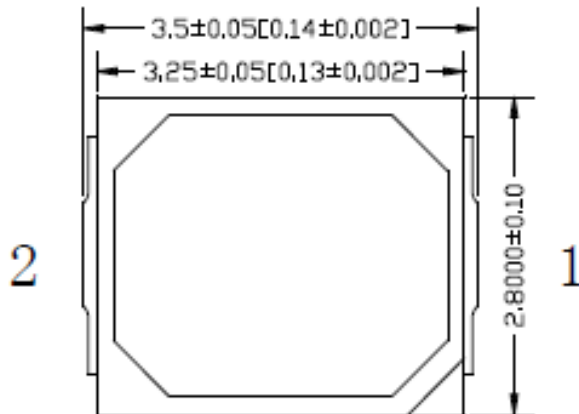
3.6 Data Set 2, 105°C, 120mA (Chromaticity Shift)

No.	u'	v'	CCT(K)	Chromaticity Shift ($\Delta u'v'$)									
	0hr(Initial)			1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs	10000hrs
26	0.2595	0.5310	2748	0.0004	0.0002	0.0006	0.0006	0.0007	0.0008	0.0009	0.0010	0.0014	0.0012
27	0.2610	0.5312	2716	0.0004	0.0003	0.0004	0.0006	0.0006	0.0008	0.0009	0.0010	0.0013	0.0011
28	0.2618	0.5330	2693	0.0004	0.0006	0.0006	0.0007	0.0009	0.0010	0.0010	0.0011	0.0012	0.0011
29	0.2621	0.5321	2690	0.0002	0.0006	0.0004	0.0005	0.0005	0.0008	0.0007	0.0008	0.0009	0.0011
30	0.2595	0.5325	2741	0.0004	0.0006	0.0005	0.0006	0.0006	0.0007	0.0008	0.0009	0.0011	0.0013
31	0.2605	0.5312	2727	0.0002	0.0005	0.0005	0.0008	0.0008	0.0010	0.0010	0.0011	0.0010	0.0014
32	0.2609	0.5322	2714	0.0002	0.0004	0.0005	0.0006	0.0006	0.0009	0.0009	0.0010	0.0011	0.0013
33	0.2612	0.5325	2706	0.0003	0.0004	0.0003	0.0003	0.0004	0.0005	0.0009	0.0005	0.0006	0.0008
34	0.2585	0.5324	2763	0.0003	0.0004	0.0005	0.0006	0.0006	0.0009	0.0013	0.0010	0.0011	0.0013
35	0.2595	0.5327	2740	0.0002	0.0004	0.0004	0.0004	0.0005	0.0004	0.0008	0.0004	0.0005	0.0007
36	0.2584	0.5324	2765	0.0002	0.0003	0.0004	0.0005	0.0004	0.0007	0.0009	0.0007	0.0008	0.0009
37	0.2606	0.5328	2718	0.0003	0.0004	0.0006	0.0006	0.0006	0.0009	0.0012	0.0006	0.0012	0.0013
38	0.2621	0.5329	2686	0.0003	0.0004	0.0004	0.0005	0.0005	0.0006	0.0009	0.0010	0.0009	0.0009
39	0.2598	0.5315	2739	0.0002	0.0004	0.0005	0.0006	0.0006	0.0007	0.0010	0.0012	0.0011	0.0011
40	0.2594	0.5319	2747	0.0002	0.0004	0.0004	0.0006	0.0006	0.0008	0.0008	0.0012	0.0011	0.0011
41	0.2597	0.5311	2743	0.0002	0.0003	0.0005	0.0006	0.0006	0.0008	0.0009	0.0013	0.0012	0.0013
42	0.2589	0.5308	2760	0.0002	0.0004	0.0003	0.0005	0.0005	0.0007	0.0008	0.0010	0.0010	0.0011
43	0.2617	0.5314	2700	0.0002	0.0004	0.0003	0.0004	0.0005	0.0006	0.0007	0.0009	0.0010	0.0009
44	0.2594	0.5318	2746	0.0002	0.0003	0.0004	0.0005	0.0006	0.0007	0.0008	0.0011	0.0015	0.0013
45	0.2610	0.5309	2717	0.0002	0.0003	0.0004	0.0006	0.0006	0.0008	0.0009	0.0012	0.0014	0.0013
46	0.2616	0.5315	2702	0.0002	0.0003	0.0005	0.0006	0.0007	0.0008	0.0009	0.0012	0.0014	0.0013
47	0.2610	0.5323	2711	0.0003	0.0004	0.0007	0.0006	0.0008	0.0007	0.0008	0.0012	0.0017	0.0013
48	0.2611	0.5334	2704	0.0003	0.0004	0.0006	0.0006	0.0007	0.0007	0.0008	0.0013	0.0014	0.0014
49	0.2591	0.5314	2755	0.0002	0.0004	0.0007	0.0006	0.0011	0.0007	0.0009	0.0012	0.0010	0.0014
50	0.2589	0.5296	2767	0.0002	0.0004	0.0004	0.0005	0.0013	0.0005	0.0007	0.0010	0.0009	0.0010
Avg.	0.2603	0.5319	2728	0.0003	0.0004	0.0005	0.0006	0.0007	0.0008	0.0009	0.0010	0.0011	0.0012
Med.	0.2605	0.5319	2727	0.0002	0.0004	0.0005	0.0006	0.0006	0.0007	0.0009	0.0010	0.0011	0.0012
st dev	0.0012	0.0009	25	0.0001	0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0002	0.0003	0.0002
Min.	0.2584	0.5296	2686	0.0002	0.0002	0.0003	0.0003	0.0004	0.0004	0.0007	0.0004	0.0005	0.0007
Max.	0.2621	0.5334	2767	0.0004	0.0006	0.0007	0.0008	0.0013	0.0010	0.0013	0.0013	0.0017	0.0014

No.	Chromaticity Shift ($\Delta u'v'$)						
	11000hrs	12000hrs	13000hrs	14000hrs	15000hrs	16000hrs	17000hrs
26	0.0014	0.0012	0.0015	0.0015	0.0019	0.0017	0.0020
27	0.0015	0.0013	0.0014	0.0015	0.0018	0.0016	0.0018
28	0.0013	0.0013	0.0015	0.0015	0.0018	0.0019	0.0021
29	0.0012	0.0013	0.0014	0.0014	0.0014	0.0016	0.0019
30	0.0012	0.0013	0.0016	0.0018	0.0015	0.0017	0.0019
31	0.0013	0.0015	0.0016	0.0018	0.0016	0.0017	0.0020
32	0.0013	0.0014	0.0015	0.0017	0.0015	0.0017	0.0019
33	0.0009	0.0012	0.0011	0.0015	0.0017	0.0019	0.0018
34	0.0012	0.0014	0.0015	0.0019	0.0021	0.0021	0.0019
35	0.0008	0.0011	0.0010	0.0014	0.0016	0.0018	0.0020
36	0.0010	0.0013	0.0012	0.0015	0.0018	0.0019	0.0017
37	0.0012	0.0015	0.0014	0.0018	0.0020	0.0022	0.0019
38	0.0009	0.0012	0.0011	0.0015	0.0018	0.0019	0.0018
39	0.0011	0.0013	0.0015	0.0017	0.0020	0.0021	0.0020
40	0.0009	0.0013	0.0015	0.0017	0.0020	0.0020	0.0020
41	0.0012	0.0015	0.0017	0.0018	0.0020	0.0020	0.0019
42	0.0015	0.0015	0.0016	0.0017	0.0019	0.0020	0.0019
43	0.0012	0.0015	0.0012	0.0013	0.0016	0.0016	0.0016
44	0.0016	0.0018	0.0016	0.0016	0.0019	0.0019	0.0018
45	0.0016	0.0018	0.0016	0.0016	0.0021	0.0021	0.0020
46	0.0016	0.0016	0.0016	0.0015	0.0019	0.0016	0.0018
47	0.0016	0.0018	0.0017	0.0016	0.0015	0.0016	0.0018
48	0.0016	0.0019	0.0016	0.0015	0.0014	0.0015	0.0019
49	0.0017	0.0018	0.0018	0.0016	0.0014	0.0016	0.0018
50	0.0012	0.0015	0.0016	0.0014	0.0011	0.0014	0.0015
Avg.	0.0013	0.0014	0.0015	0.0016	0.0017	0.0018	0.0019
Med.	0.0012	0.0014	0.0015	0.0016	0.0018	0.0018	0.0019
st dev	0.0003	0.0002	0.0002	0.0001	0.0003	0.0002	0.0001
Min.	0.0008	0.0011	0.0010	0.0013	0.0011	0.0014	0.0015
Max.	0.0017	0.0019	0.0018	0.0019	0.0021	0.0022	0.0021

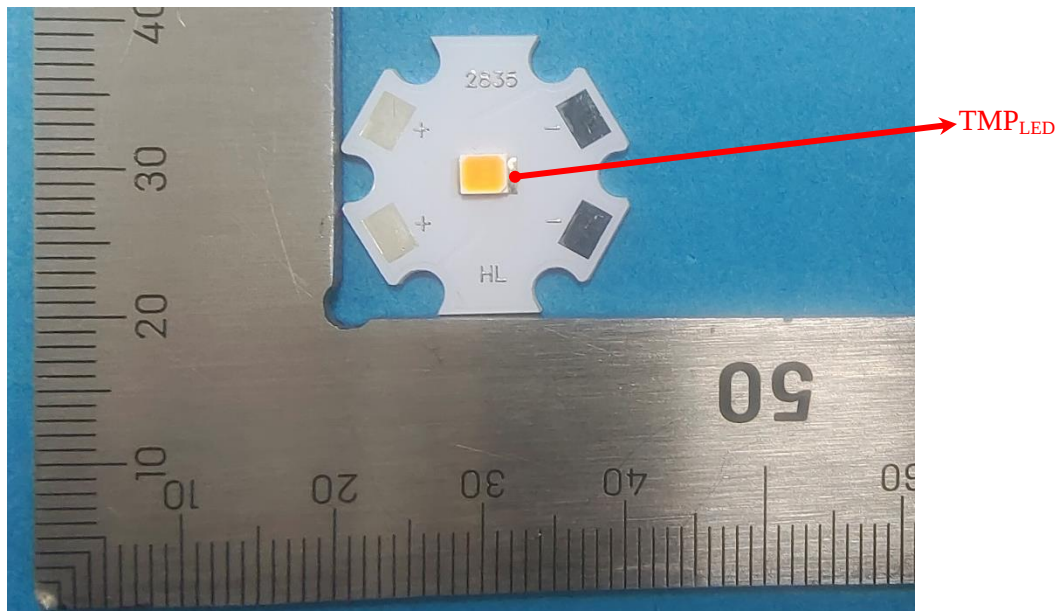
4 - DUT Photo

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