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Lab Code:TL-460

Bay Area Compliance Labs Corp.

IES LM-80-2008

MEASURING LUMEN MAINTENANCE OF LED LIGHT SOURCES

MEASUREMENT AND TEST REPORT

Model: 3528HW

Report Type: 6000 Hours Test Report	**Product Type:** LED Package
Test Engineer:	Jack Zhou Jack. zhou
Report Number:	RSZ110803501-10-M3
Test Date:	2011-08-03 to 2012-04-09
Report Date:	2013-05-27
Revision Note:	The previous report RSZ110803501-10-M2 is replaced by this report. A footnote is added in this report.
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COMPLIANCE TESTING AND VERIFICATION SERVICES BACL

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). The previous report with report No: RSZ110803501-10-M1 was replaced by this report. This report is valid only with a valid digital signature. The digital signature may be available only under the Adobe software above version 7.0.

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1 - GENERAL INFORMATION

1.1 Description of LED Light Sources

Devices tested

Part Number: 3528HW
Part Name: /
Part Type: LED Package
Nominal CCT: 6500K

1.2 Standards Used:

- IESNA LM-80-08: IES Approved Method for Measuring Lumen Maintenance of LED Light Sources.

1.3 Test Facility

The testing facility used by Bay Area Compliance Laboratories Corp. (Dongguan). is located at Pu Long Cun 69, Puxinghu Industrial Area, Tangxia Town, Dongguan, Guangdong, P.R.China.

1.4 Description of Auxiliary Equipment

Device	Manufacture	Model No	Serial No	Test Range	Calibration date	Calibration due date
Integral Sphere	EVERFINE	Diameter 0.3M	1011119	380-780nm, lamp length:0.3M ,0-1999LUMEN	2012-02-19	2013-02-18
Programmable Test Power for LEDs	EVERFINE	LED300E	1008002	15V/2000mA	2012-02-15	2013-02-14
Standard Light Source	EVERFINE	D062	1011064	N/A	2012-02-23	2013-02-22
High accuracy array spectroradiometer	EVERFINE	HAAS-2000	1012016T	/	2012-02-15	2013-02-14

1.5 Operating Cycle

Samples are driven with a constant direct current (DC)

1.6 Ambient conditions

For lumen maintenance test, samples were operated in thermal chambers with minimal ambient airflow. For long term reliability test, the case temperature was controlled by mounting several thermocouples on a sample reliability stress board at the designated thermal measurement point, as shown in APPENDIX. The ambient temperature T_A was measured by several thermocouples at a distance of 1.5 mm above the reliability test board. The relative humidity within chamber was less than 65%.

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

1.7 Photometry Measurement Uncertainty

The uncertainty of the light output measurements is U=1.50% (K=2), at the 95% confidence level. The uncertainty of the correlated color temperature measurements is U=14K (K=2), at the 95% confidence level. This calibration results traceable to the NATIONAL INSTITUTE OF METROLOGY (NIM).

1.8 Sample Set

Data Set 1: 55°C, 20mA	
Part Number:	3528HW
Number of Units:	25
Actual Case Temperature(T_S):	T_S =54.9°C
Actual Ambient Temperature(T_A):	T_A =54.8°C
Life Test Drive Current:	I_F = 20mA
Measurement Current:	I_F = 20mA

Data Set 2: 70°C, 20mA	
Part Number:	3528HW
Number of Units:	25
Actual Case Temperature(T_S):	T_S =69.9°C
Actual Ambient Temperature(T_A):	T_A =69.8°C
Life Test Drive Current:	I_F = 20mA
Measurement Current:	I_F =20mA

Data Set 3: 85°C, 20mA	
Part Number:	3528HW
Number of Units:	25
Actual Case Temperature(T_S):	T_S =84.8°C
Actual Ambient Temperature(T_A):	T_A =84.6°C
Life Test Drive Current:	I_F = 20mA
Measurement Current:	I_F = 20mA

2 - SUMMARY OF TEST RESULT

Data Set:	**Data Set 1, 55°C, 20mA**
Number of Units:	25
Failures Observed:	0
Average. Lumen Maintenance at 6000 hours:	101.32%
Average Chromaticity Shift at 6000 hours (Δu'v'):	0.0024
Reported TM-21 L_{70} Lifetime	>36000 hours

Data Set:	**Data Set 2, 70°C, 20mA**
Number of Units:	25
Failures Observed:	0
Average. Lumen Maintenance at 6000 hours:	100.01%
Average Chromaticity Shift at 6000 hours(Δu'v'):	0.0022
Reported TM-21 L_{70} Lifetime	>36000 hours

Data Set:	**Data Set 3, 85°C, 20mA**
Number of Units:	25
Failures Observed:	0
Average. Lumen Maintenance at 6000 hours:	99.13%
Average Chromaticity Shift at 6000 hours(Δu'v'):	0.0015
Reported TM-21 L_{70} Lifetime	>36000 hours

3 - Test Data

3.1 Data Set 1, 55°C, 20mA (Lumen Maintenance)

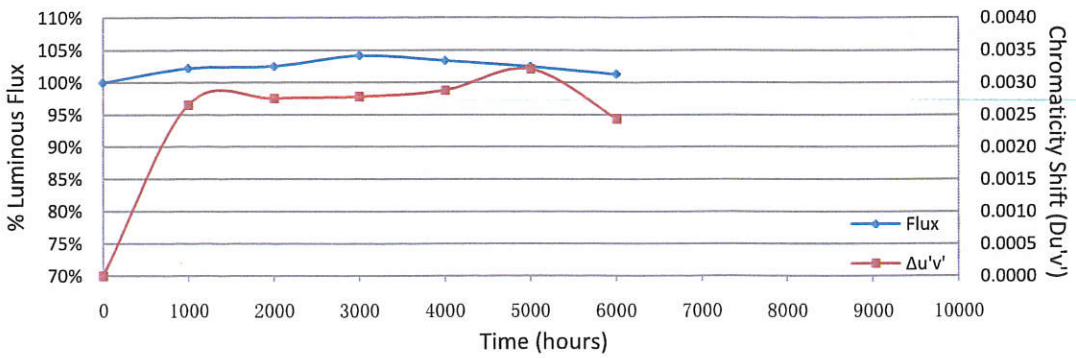
No.	VF(V)	Φ(lm)	Lumen Maintenance (%)					
	0hr(Initial)		1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs
1	3.024	7.802	102.36	100.14	101.36	100.85	100.67	100.19
2	3.031	7.516	103.58	102.01	105.84	105.20	104.23	102.82
3	3.018	7.473	103.04	103.25	106.25	105.77	104.31	103.28
4	3.016	8.026	102.19	99.94	100.85	100.45	99.44	99.05
5	3.026	7.642	101.99	101.53	104.42	104.08	103.35	102.07
6	3.026	7.590	100.83	100.76	104.15	103.65	103.28	102.09
7	3.022	7.542	102.17	102.19	105.10	104.64	104.19	102.63
8	3.023	7.513	102.40	102.01	104.75	103.94	102.65	101.38
9	3.017	7.798	99.08	99.15	101.38	100.73	100.00	99.51
10	3.024	7.943	101.91	99.71	100.65	99.89	99.36	99.13
11	3.026	7.530	104.04	105.27	106.39	104.99	103.68	102.22
12	3.025	7.439	103.90	105.38	106.22	105.61	104.58	102.85
13	3.019	7.712	99.70	100.23	101.96	101.45	100.34	98.98
14	3.030	7.418	103.95	104.85	106.69	105.51	103.95	102.10
15	3.024	7.861	101.90	100.03	100.59	100.08	99.03	98.65
16	3.028	7.480	103.16	104.53	106.07	105.61	104.32	103.10
17	3.021	7.560	102.31	103.62	105.50	105.09	103.60	101.92
18	3.022	7.459	103.31	104.73	105.55	105.05	104.14	102.75
19	3.021	7.568	102.29	103.66	104.82	102.63	102.27	100.81
20	3.018	7.873	99.12	100.06	101.71	101.23	99.95	99.56
21	3.018	7.523	102.59	104.60	105.85	102.50	101.95	100.64
22	3.022	7.625	101.90	103.58	104.50	103.93	102.65	100.80
23	3.026	7.560	102.34	103.51	104.71	104.10	103.56	102.04
24	3.020	7.662	102.00	102.34	103.15	102.41	101.57	100.80
25	3.024	7.296	103.48	105.56	106.35	105.83	104.45	103.74
Ave.	3.023	7.616	102.22	102.51	104.19	103.41	102.46	101.32
Med.	3.023	7.560	102.31	102.34	104.75	103.94	103.28	101.92
st dev	0.004	0.179	0.013	0.021	0.021	0.020	0.019	0.015
Min.	3.016	7.296	99.08	99.15	100.59	99.89	99.03	98.65
Max.	3.031	8.026	104.04	105.56	106.69	105.83	104.58	103.74

TM-21 Projection:

Test Duration: 6000 hours
Failures Observed: 0
α: 1.520E-06
β: 1.032
Calculated L_{70}: 256,000 hours
Reported L_{70}: >36000 hours

3.2 Data Set 1, 55°C, 20mA (Chromaticity Shift)

No.	u'	v'	Chromaticity Shift (Δu'v')					
	0hr(Initial)		1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs
1	0.2005	0.4583	0.0015	0.0017	0.0014	0.0014	0.0016	0.0017
2	0.2017	0.4591	0.0032	0.0033	0.0033	0.0034	0.0037	0.0031
3	0.2014	0.4619	0.0028	0.0026	0.0029	0.0031	0.0032	0.0030
4	0.1989	0.4671	0.0014	0.0015	0.0014	0.0016	0.0019	0.0010
5	0.2003	0.4625	0.0031	0.0028	0.0030	0.0031	0.0036	0.0025
6	0.2002	0.4603	0.0014	0.0025	0.0031	0.0031	0.0038	0.0028
7	0.2001	0.463	0.0034	0.0031	0.0033	0.0035	0.0038	0.0031
8	0.2001	0.4617	0.0034	0.0032	0.0034	0.0035	0.0045	0.0032
9	0.1999	0.4631	0.0013	0.0013	0.0014	0.0014	0.0018	0.0016
10	0.2012	0.4666	0.0016	0.0017	0.0015	0.0016	0.0021	0.0017
11	0.2004	0.463	0.0033	0.0031	0.0032	0.0036	0.0037	0.0028
12	0.2021	0.461	0.0035	0.0036	0.0036	0.0036	0.0040	0.0029
13	0.2013	0.4641	0.0015	0.0016	0.0016	0.0016	0.0019	0.0018
14	0.2028	0.4595	0.0039	0.0038	0.0040	0.0039	0.0043	0.0057
15	0.2007	0.4597	0.0015	0.0015	0.0015	0.0015	0.0017	0.0017
16	0.2016	0.4624	0.0030	0.0030	0.0031	0.0032	0.0036	0.0022
17	0.2019	0.4649	0.0034	0.0034	0.0035	0.0036	0.0038	0.0026
18	0.2039	0.461	0.0037	0.0038	0.0039	0.0040	0.0045	0.0033
19	0.2007	0.459	0.0032	0.0032	0.0034	0.0037	0.0038	0.0027
20	0.2011	0.4636	0.0014	0.0016	0.0015	0.0015	0.0017	0.0011
21	0.1995	0.4632	0.0035	0.0036	0.0034	0.0036	0.0038	0.0021
22	0.2019	0.4645	0.0029	0.0031	0.0031	0.0034	0.0037	0.0019
23	0.2021	0.4628	0.0032	0.0037	0.0031	0.0031	0.0037	0.0022
24	0.2025	0.4619	0.0017	0.0025	0.0024	0.0023	0.0025	0.0015
25	0.2012	0.4564	0.0033	0.0034	0.0032	0.0033	0.0036	0.0025
Ave.	0.2011	0.4620	0.0026	0.0028	0.0028	0.0029	0.0032	0.0024
Med.	0.2012	0.4624	0.0031	0.0031	0.0031	0.0032	0.0037	0.0025
st dev	0.0011	0.0025	0.0009	0.0008	0.0009	0.0009	0.0010	0.0009
Min.	0.1989	0.4564	0.0013	0.0013	0.0014	0.0014	0.0016	0.0010
Max.	0.2039	0.4671	0.0039	0.0038	0.0040	0.0040	0.0045	0.0057



3.3 Data Set 2, 70°C, 20mA (Lumen Maintenance)

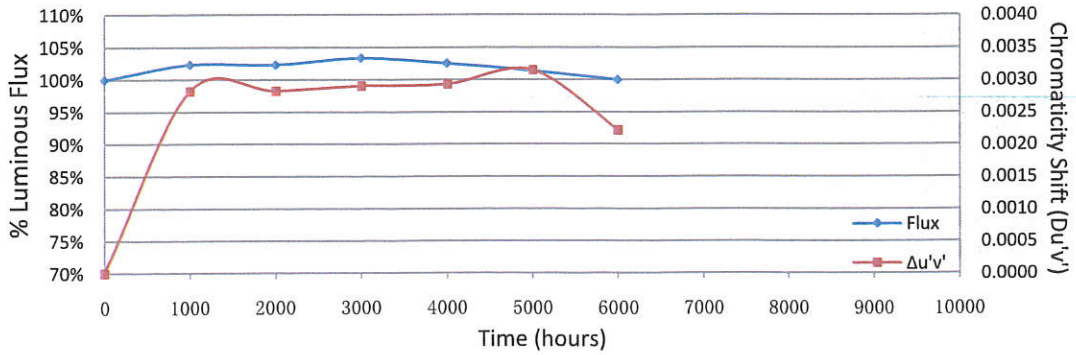
No.	VF(V)	Φ(lm)	Lumen Maintenance (%)					
	0hr(Initial)		1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs
1	3.032	7.443	103.39	100.99	102.83	101.32	100.55	99.45
2	3.032	7.834	101.86	98.02	99.62	99.40	98.39	97.79
3	3.024	8.021	101.06	98.94	99.39	99.34	98.20	97.93
4	3.024	7.878	99.10	100.77	101.50	101.17	100.15	99.02
5	3.025	7.321	105.31	107.06	107.28	106.87	105.60	103.17
6	3.027	7.752	100.22	100.28	101.28	101.06	100.05	99.12
7	3.023	7.861	102.44	100.36	99.82	99.86	98.73	98.10
8	3.024	7.455	103.02	103.51	104.52	104.52	103.31	100.76
9	3.020	7.470	102.81	104.87	105.31	104.94	103.98	101.27
10	3.026	7.939	102.04	100.14	100.49	100.06	98.77	98.40
11	3.021	7.518	101.52	103.37	103.41	102.08	101.57	99.81
12	3.023	7.414	102.99	101.66	104.03	103.56	102.39	100.73
13	3.025	7.512	103.17	101.74	104.98	100.24	98.67	98.16
14	3.026	7.434	103.81	105.54	106.01	105.64	104.06	101.30
15	3.029	7.486	103.62	105.26	105.94	105.58	104.25	102.20
16	3.023	7.440	103.43	104.49	106.01	105.59	104.13	102.45
17	3.025	7.146	106.05	103.69	106.84	106.54	105.14	103.08
18	3.015	7.550	102.57	104.21	104.87	99.81	98.37	97.83
19	3.023	7.674	99.93	101.94	102.14	101.38	100.42	99.43
20	3.021	7.833	100.52	100.55	101.19	100.65	100.00	99.00
21	3.021	7.638	99.14	99.96	101.32	100.68	99.83	99.07
22	3.024	7.926	102.37	99.04	100.62	100.15	99.50	98.81
23	3.024	7.450	103.49	105.41	105.50	104.91	103.81	101.34
24	3.021	7.626	99.31	101.82	102.02	101.30	99.61	98.54
25	3.024	7.298	105.55	104.26	107.26	106.73	105.22	103.48
Ave.	3.024	7.597	102.35	102.32	103.37	102.54	101.39	100.01
Med.	3.024	7.518	102.57	101.82	103.41	101.32	100.42	99.43
st dev	0.004	0.229	0.019	0.024	0.026	0.026	0.025	0.018
Min.	3.015	7.146	99.10	98.02	99.39	99.34	98.20	97.79
Max.	3.032	8.021	106.05	107.06	107.28	106.87	105.60	103.48

TM-21 Projection:

Test Duration: 6000 hours
Failures Observed: 0
α: 4.317E-06
β: 1.035
Calculated L_{70}: 91,000 hours
Reported L_{70}: >36000 hours

3.4 Data Set 2, 70°C, 20mA (Chromaticity Shift)

No.	u'	v'	Chromaticity Shift (Δu'v')					
	0hr(Initial)		1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs
1	0.2017	0.456	0.0035	0.0036	0.0035	0.0039	0.0042	0.0035
2	0.2021	0.4604	0.0011	0.0009	0.0011	0.0011	0.0011	0.0010
3	0.2004	0.4657	0.0010	0.0012	0.0010	0.0010	0.0011	0.0009
4	0.1995	0.4619	0.0015	0.0017	0.0017	0.0017	0.0019	0.0010
5	0.2031	0.4592	0.0040	0.0044	0.0045	0.0046	0.0049	0.0040
6	0.2004	0.4598	0.0030	0.0015	0.0015	0.0015	0.0018	0.0016
7	0.2007	0.4621	0.0016	0.0019	0.0016	0.0017	0.0021	0.0019
8	0.2007	0.4574	0.0036	0.0032	0.0034	0.0036	0.0041	0.0024
9	0.2017	0.4582	0.0034	0.0035	0.0038	0.0040	0.0043	0.0029
10	0.2002	0.4683	0.0021	0.0020	0.0016	0.0015	0.0018	0.0017
11	0.2021	0.4607	0.0028	0.0030	0.0033	0.0034	0.0039	0.0029
12	0.2006	0.463	0.0034	0.0030	0.0030	0.0030	0.0032	0.0028
13	0.2005	0.461	0.0037	0.0035	0.0039	0.0036	0.0039	0.0031
14	0.2011	0.459	0.0040	0.0041	0.0045	0.0046	0.0045	0.0035
15	0.2026	0.4625	0.0038	0.0038	0.0041	0.0041	0.0044	0.0029
16	0.2013	0.463	0.0034	0.0035	0.0037	0.0037	0.0040	0.0027
17	0.205	0.4573	0.0050	0.0047	0.0051	0.0051	0.0052	0.0025
18	0.1994	0.4659	0.0036	0.0037	0.0040	0.0039	0.0039	0.0026
19	0.2023	0.4613	0.0020	0.0022	0.0021	0.0021	0.0024	0.0011
20	0.2006	0.4654	0.0015	0.0017	0.0015	0.0015	0.0017	0.0012
21	0.2001	0.4687	0.0016	0.0023	0.0020	0.0019	0.0017	0.0009
22	0.1992	0.466	0.0017	0.0016	0.0018	0.0019	0.0021	0.0019
23	0.2023	0.4611	0.0036	0.0037	0.0037	0.0038	0.0040	0.0019
24	0.2008	0.4586	0.0016	0.0018	0.0017	0.0018	0.0021	0.0019
25	0.2033	0.4608	0.0039	0.0041	0.0043	0.0042	0.0045	0.0026
Ave.	0.2013	0.4617	0.0028	0.0028	0.0029	0.0029	0.0031	0.0022
Med.	0.2008	0.4611	0.0034	0.0030	0.0033	0.0034	0.0039	0.0024
st dev	0.0014	0.0034	0.0011	0.0011	0.0013	0.0013	0.0013	0.0009
Min.	0.1992	0.4560	0.0010	0.0009	0.0010	0.0010	0.0011	0.0009
Max.	0.2050	0.4687	0.0050	0.0047	0.0051	0.0051	0.0052	0.0040



3.5 Data Set 3, 85°C, 20mA (Lumen Maintenance)

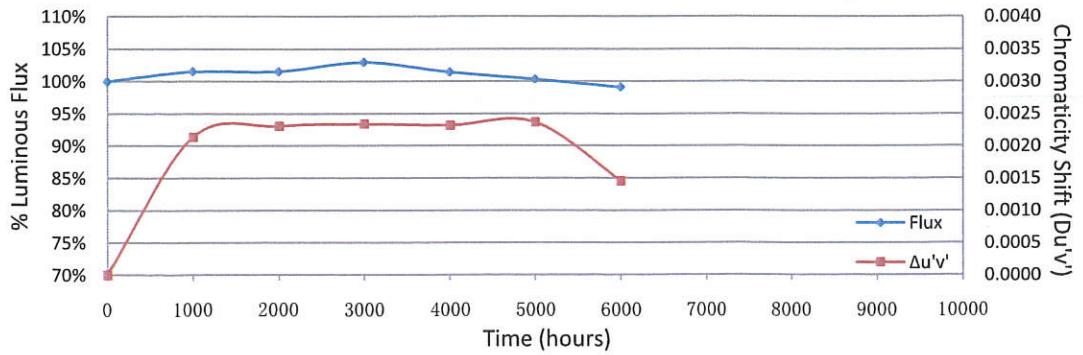
No.	VF(V)	Φ(lm)	Lumen Maintenance (%)					
	0hr(Initial)		1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs
1	3.010	7.619	100.09	98.90	103.70	102.26	101.40	99.21
2	3.012	7.503	101.75	102.91	103.23	102.45	101.53	100.19
3	3.018	7.349	101.40	103.01	103.63	102.99	101.96	100.03
4	3.008	7.533	101.09	101.02	101.43	100.36	99.35	98.70
5	3.017	7.538	100.62	101.68	102.16	100.97	99.79	99.63
6	3.017	7.504	104.26	106.20	106.94	105.77	104.88	102.88
7	3.010	7.651	100.37	100.77	101.25	100.10	99.27	98.58
8	3.007	7.454	99.93	101.91	106.43	105.77	104.13	102.56
9	3.012	7.550	100.98	102.36	102.86	91.87	91.52	91.10
10	3.023	7.540	100.66	101.78	102.24	100.84	99.23	98.32
11	3.023	7.861	99.52	98.96	98.00	96.62	96.02	95.22
12	3.016	7.757	101.57	101.77	101.53	100.22	99.17	98.45
13	3.028	7.388	102.22	102.88	103.30	101.89	101.02	99.76
14	3.027	7.567	101.92	100.74	100.98	99.91	99.34	98.22
15	3.018	7.611	101.62	98.78	104.03	102.98	101.97	100.18
16	3.021	7.510	102.16	103.10	103.42	102.42	100.83	99.17
17	3.024	7.905	101.92	99.53	99.20	98.00	97.17	96.57
18	3.024	7.459	103.32	104.89	104.45	103.42	101.80	100.16
19	3.023	7.509	103.57	100.28	104.23	102.92	101.31	99.93
20	3.022	7.421	99.41	101.78	105.39	104.53	103.37	101.71
21	3.017	7.341	102.27	104.05	104.54	103.20	101.73	100.40
22	3.018	7.788	99.26	99.29	99.68	98.10	97.23	96.56
23	3.024	7.480	102.93	103.70	104.51	103.53	102.03	100.48
24	3.018	7.443	102.49	99.26	103.72	102.65	101.12	100.51
25	3.021	7.470	102.38	99.32	103.12	102.02	100.47	99.77
Ave.	3.018	7.550	101.51	101.55	102.96	101.43	100.30	99.13
Med.	3.018	7.510	101.62	101.77	103.30	102.26	101.02	99.76
st dev	0.0059	0.1467	1.3232	2.0074	2.1162	2.9951	2.7637	2.4069
Min.	3.007	7.341	99.26	98.78	98.00	91.87	91.52	91.10
Max.	3.028	7.905	104.26	106.20	106.94	105.77	104.88	102.88

TM-21 Projection:

Test Duration: 6000 hours
Failures Observed: 0
α: 4.879E-06
β: 1.029
Calculated L_{70}: 79,000 hours
Reported L_{70}: >36000 hours

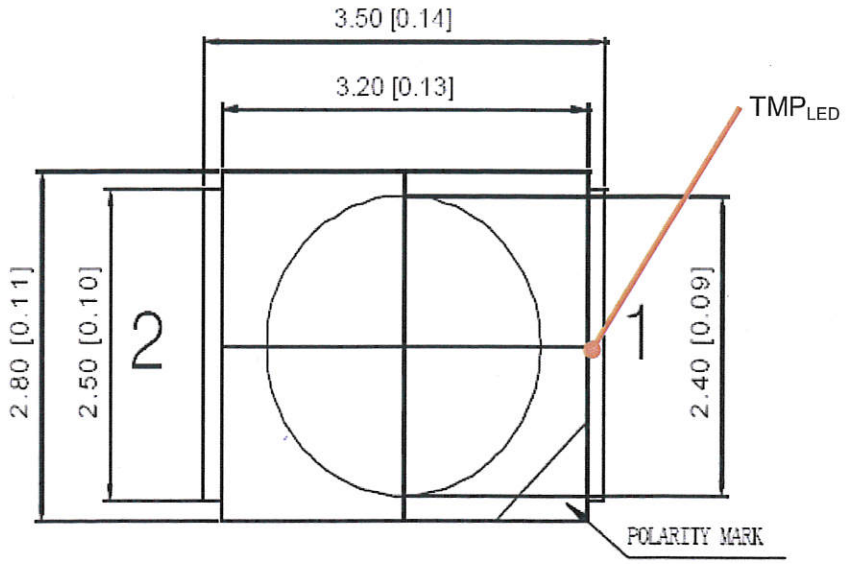
3.6 Data Set 3, 85°C, 20mA (Chromaticity Shift)

No.	u'	v'	Chromaticity Shift (Δu'v')					
	0hr(Initial)		1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs
1	0.1997	0.4665	0.0018	0.0009	0.0021	0.0021	0.0021	0.0022
2	0.1982	0.4639	0.0004	0.0004	0.0002	0.0001	0.0004	0.0001
3	0.2005	0.4639	0.0004	0.0010	0.0007	0.0006	0.0007	0.0005
4	0.1991	0.4601	0.0002	0.0003	0.0007	0.0009	0.0005	0.0007
5	0.2007	0.467	0.0007	0.0005	0.0003	0.0003	0.0003	0.0009
6	0.1983	0.4674	0.0029	0.0030	0.0029	0.0027	0.0031	0.0008
7	0.1988	0.4632	0.0002	0.0009	0.0007	0.0009	0.0005	0.0008
8	0.1994	0.4627	0.0004	0.0009	0.0009	0.0010	0.0012	0.0007
9	0.1989	0.4635	0.0004	0.0005	0.0004	0.0018	0.0007	0.0008
10	0.2003	0.4604	0.0036	0.0035	0.0038	0.0034	0.0033	0.0022
11	0.2007	0.4607	0.0011	0.0031	0.0013	0.0013	0.0013	0.0015
12	0.2032	0.4692	0.0022	0.0031	0.0028	0.0025	0.0026	0.0019
13	0.2015	0.4598	0.0036	0.0034	0.0035	0.0032	0.0036	0.0020
14	0.2002	0.4611	0.0032	0.0031	0.0033	0.0031	0.0034	0.0024
15	0.2002	0.4631	0.0036	0.0015	0.0016	0.0017	0.0017	0.0027
16	0.2003	0.4599	0.0035	0.0033	0.0034	0.0033	0.0036	0.0017
17	0.1997	0.4615	0.0015	0.0016	0.0014	0.0012	0.0013	0.0011
18	0.2018	0.4626	0.0038	0.0040	0.0040	0.0039	0.0041	0.0020
19	0.2021	0.4613	0.0039	0.0040	0.0038	0.0036	0.0039	0.0021
20	0.2004	0.4577	0.0016	0.0037	0.0045	0.0045	0.0047	0.0026
21	0.2016	0.4606	0.0028	0.0032	0.0035	0.0038	0.0036	0.0013
22	0.1994	0.4619	0.0010	0.0020	0.0022	0.0020	0.0021	0.0009
23	0.2006	0.4609	0.0035	0.0033	0.0035	0.0033	0.0036	0.0006
24	0.201	0.4567	0.0036	0.0033	0.0034	0.0032	0.0035	0.0018
25	0.2022	0.4606	0.0035	0.0032	0.0035	0.0033	0.0034	0.0021
Ave.	0.2004	0.4622	0.0021	0.0023	0.0023	0.0023	0.0024	0.0015
Med.	0.2003	0.4615	0.0022	0.0031	0.0028	0.0025	0.0026	0.0015
st dev	0.0013	0.0029	0.0014	0.0013	0.0014	0.0013	0.0014	0.0008
Min.	0.1982	0.4567	0.0002	0.0003	0.0002	0.0001	0.0003	0.0001
Max.	0.2032	0.4692	0.0039	0.0040	0.0045	0.0045	0.0047	0.0027

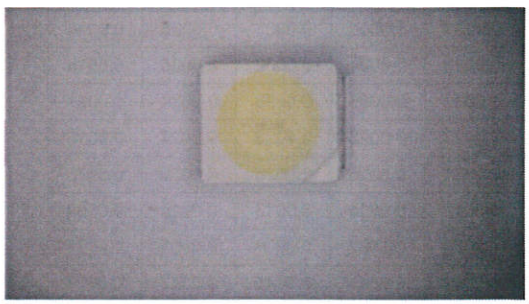


Appendix A – EUT PHOTO

A.1 Mechanical Dimensions (Ta = 25°C)



A.2 EUT Photo



Appendix B – REVISION HISTORY

Report Number	Report Date	Contents
RSZ110803501-10	2012/04/09	Original report.
RSZ110803501-10-M1	2012/04/28	Correct the typos of some titles.
RSZ110803501-10-M2	2013/02/01	Update the Logo of lab, note information on page 1. Remove the inappropriate description in section 1.2 and 1.3. Correct typos in section 1.6. Update part of border, font and shading. Add unit for forward voltage and life time.
RSZ110803501-10-M3	2013/05/27	A footnote is added in the first page.

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