

IES LM-80-2008

MEASURING LUMEN MAINTENANCE OF LED LIGHT SOURCES

MEASUREMENT AND TEST REPORT

For

Sharp Corporation, Electronic Components and Device Group, Lighting Device Division

247, Soujou, Nutanishi-cho, Mihara, Hiroshima 729-0474, Japan

Model: GW5BMK30K04

Report Type: Original Report	Product Type: LED chips
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1 - GENERAL INFORMATION

1.1 Description of LED light sources

Devices tested:

Part Number: GW5BMK30K04
 Part Name: /
 Part Type: LED Package
 Nominal CCT: 3000K

This report covers the following models:

Series	Model	CCT (K)	CRI	Current (mA)	Chip layout	
					Series	Parallel
GW5BMK**K04	GW5BMK27K04	2700	80	360	12	6
	GW5BMK30K04	3000	80	360	12	6
	GW5BMK35K04	3500	80	360	12	6
	GW5BMK40K04	4000	80	360	12	6
	GW5BMK50K04	5000	80	360	12	6
	GW5BMK65K04	6500	80	360	12	6
GW5BMW**KF4	GW5BMW27KF4	2700	80	180	12	3
	GW5BMW30KF4	3000	80	180	12	3
	GW5BMW35KF4	3500	80	180	12	3
	GW5BMW40KF4	4000	80	180	12	3
	GW5BMW50KF4	5000	80	180	12	3
	GW5BMW65KF4	6500	80	180	12	3
GW5BMW**K04	GW5BMW27K04	2700	80	180	12	4
	GW5BMW30K04	3000	80	180	12	4
	GW5BMW35K04	3500	80	180	12	4
	GW5BMW40K04	4000	80	180	12	4
	GW5BMW50K04	5000	80	180	12	4
	GW5BMW65K04	6500	80	180	12	4
GW5BMF**K04	GW5BMF27K04	2700	80	480	4	8
	GW5BMF30K04	3000	80	480	4	8
	GW5BMF35K04	3500	80	480	4	8
	GW5BMF40K04	4000	80	480	4	8
	GW5BMF50K04	5000	80	480	4	8
	GW5BMF65K04	6500	80	480	4	8

1.2 Standards Used

- IESNA LM-80-08: IES Approved Method for Measuring Lumen Maintenance of LED Light Sources.
- ENERGY STAR® Program Guidance Regarding LED chips, LED Array and LED Module Lumen Maintenance Performance Data Supporting Qualification of Lighting Products

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.

Bay Area Compliance Laboratories Corp. (Dongguan). is the International Accreditation Service (IAS) accredited laboratory. The IAS Lab Code is TL-460.

Bay Area Compliance Laboratories Corp. (Dongguan) is recognized by EPA to test LED package, module or array (IES LM-80-2008) for the ENERGY STAR program.

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, 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 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 $25\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$, 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 $U=14\text{K}$ ($K=2$), at the 95% confidence level. This calibration results traceable to the NATIONAL INSTITUTE OF METROLOGY (NIM).

1.8 Sample Set**Data Set 1: 85 °C, 360mA**

Part Number:	GW5BMK30K04
Number of Units:	10
Actual Case Temperature(T_S):	$T_S = 84.2 \text{ }^\circ\text{C}$
Actual Ambient Temperature(T_A):	$T_A = 83.7 \text{ }^\circ\text{C}$
Life Test Drive Current:	$I_F = 360\text{mA}$
Measurement Current:	$I_F = 360\text{mA}$

Data Set 2: 100 °C, 280mA

Part Number:	GW5BMK30K04
Number of Units:	10
Actual Case Temperature(T_S):	$T_S = 99.7 \text{ }^\circ\text{C}$
Actual Ambient Temperature(T_A):	$T_A = 96.8 \text{ }^\circ\text{C}$
Life Test Drive Current:	$I_F = 280\text{mA}$
Measurement Current:	$I_F = 280\text{mA}$

2 - SUMMARY OF TEST RESULT

Data Set:	Data Set 1, 85 °C, 360mA
Number of Units:	10
Failures Observed:	0
Average. Lumen Maintenance at 6000 hours:	97.55%
Average Chromaticity Shift at 6000 hours ($\Delta u'v'$):	0.0006
Reported TM-21 L ₇₀ Lifetime	>33000

Data Set:	Data Set 2, 100 °C, 280mA
Number of Units:	10
Failures Observed:	0
Average. Lumen Maintenance at 6000 hours:	97.25%
Average Chromaticity Shift at 6000 hours ($\Delta u'v'$):	0.0006
Reported TM-21 L ₇₀ Lifetime	>33000

3 - Test Data

3.1 Data Set 1, 85 °C, 360mA (Lumen maintenance)

No.	VF	Φ(lm)	Lumen maintenance (%)					
	0hr(Initial)		1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs
1	35.66	1253	99.68	99.12	98.40	98.24	97.77	97.45
2	35.84	1269	100.87	100.16	99.68	98.98	98.03	97.56
3	35.93	1291	100.15	99.46	98.68	98.37	97.75	97.52
4	35.92	1302	100.84	100.46	99.77	99.23	98.16	97.70
5	35.98	1308	99.62	99.46	98.70	98.39	97.86	97.63
6	36.08	1312	99.54	99.16	98.25	98.02	97.56	97.41
7	36.30	1277	100.08	99.61	99.14	98.67	98.04	97.57
8	36.31	1281	101.01	100.39	99.53	98.99	98.13	97.58
9	36.24	1275	99.53	99.06	98.51	98.27	97.73	97.49
10	36.36	1275	100.63	100.00	99.14	98.59	97.88	97.57
Ave.	36.06	1284	100.20	99.69	98.98	98.58	97.89	97.55
Med.	36.03	1279	100.12	99.54	98.92	98.49	97.87	97.56
st dev	0.2343	18.6729	0.5976	0.0053	0.5509	0.3876	0.1944	0.0847
Min.	35.66	1253	99.53	99.06	98.25	98.02	97.56	97.41
Max.	36.36	1312	101.01	100.46	99.77	99.23	98.16	97.70

TM-21 Projection:

Test Duration: 6000 hours
Failures Observed: 0
 α : 5.505E-06
 β : 1.007
Calculated L₇₀: 66,000
Reported L₇₀: >33000

3.2 Data Set 1, 85 °C, 360mA (Luminous Flux)

No.	Luminous Flux (lm)						
	0hr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs
1	1253	1249	1242	1233	1231	1225	1221
2	1269	1280	1271	1265	1256	1244	1238
3	1291	1293	1284	1274	1270	1262	1259
4	1302	1313	1308	1299	1292	1278	1272
5	1308	1303	1301	1291	1287	1280	1277
6	1312	1306	1301	1289	1286	1280	1278
7	1277	1278	1272	1266	1260	1252	1246
8	1281	1294	1286	1275	1268	1257	1250
9	1275	1269	1263	1256	1253	1246	1243
10	1275	1283	1275	1264	1257	1248	1244
Ave.	1284	1287	1280	1271	1266	1257	1253
Med.	1279	1288	1280	1270	1264	1255	1248
st dev	18.6729	19.1242	20.0558	19.1822	18.7023	18.0850	18.5161
Min.	1253	1249	1242	1233	1231	1225	1221
Max.	1312	1313	1308	1299	1292	1280	1278

3.3 Data Set 1, 85 °C, 360mA (Chromaticity Coordinates - CIE 1931)

No.	Chromaticity Coordinates (CIE 1931)													
	0hr(Initial)		1000hrs		2000hrs		3000hrs		4000hrs		5000hrs		6000hrs	
	x	y	x	y	x	y	x	y	x	y	x	y	x	y
1	0.4198	0.3908	0.4192	0.3910	0.4195	0.3911	0.4194	0.3910	0.4194	0.391	0.4192	0.3908	0.4195	0.3906
2	0.4199	0.3923	0.4183	0.3926	0.4191	0.3923	0.4192	0.3921	0.4192	0.3921	0.4201	0.3914	0.4202	0.3916
3	0.4191	0.3912	0.4178	0.3907	0.4178	0.3908	0.4183	0.3909	0.4183	0.3909	0.418	0.3913	0.4173	0.3899
4	0.4194	0.3917	0.4185	0.3915	0.4184	0.3914	0.4190	0.3918	0.419	0.3918	0.4203	0.3925	0.4205	0.3920
5	0.4200	0.3920	0.4191	0.3918	0.4191	0.3924	0.4194	0.3923	0.4194	0.3923	0.419	0.3919	0.4197	0.3927
6	0.4203	0.3918	0.4194	0.3919	0.4202	0.3922	0.4198	0.3916	0.4198	0.3916	0.4207	0.3935	0.4211	0.3924
7	0.4195	0.3921	0.4183	0.3914	0.4187	0.3917	0.4188	0.3914	0.4188	0.3914	0.4208	0.393	0.4190	0.3919
8	0.4193	0.3920	0.4188	0.3921	0.4192	0.3921	0.4187	0.3912	0.4187	0.3912	0.4202	0.3923	0.4197	0.3932
9	0.4201	0.3923	0.4194	0.3924	0.4193	0.3925	0.4194	0.3929	0.4194	0.3929	0.4191	0.3922	0.4195	0.3930
10	0.4209	0.3927	0.4200	0.3922	0.4205	0.3925	0.4202	0.3921	0.4202	0.3921	0.4212	0.3924	0.4222	0.3934
Ave.	0.4198	0.3918	0.4189	0.3918	0.4192	0.3919	0.4192	0.3917	0.4192	0.3917	0.4199	0.3921	0.4199	0.3921
Med.	0.4197	0.3920	0.4190	0.3919	0.4192	0.3922	0.4193	0.3917	0.4193	0.3917	0.4202	0.3923	0.4197	0.3922
st dev	0.0007	0.0004	0.0007	0.0006	0.0008	0.0006	0.0006	0.0006	0.0006	0.0006	0.0010	0.0008	0.0013	0.0011
Min.	0.4187	0.3908	0.4178	0.3907	0.4178	0.3908	0.4183	0.3909	0.4183	0.3909	0.4180	0.3908	0.4173	0.3899
Max.	0.4214	0.3927	0.4200	0.3926	0.4205	0.3925	0.4202	0.3929	0.4202	0.3929	0.4212	0.3935	0.4222	0.3934

3.4 Data Set 1, 85 °C, 360mA (Chromaticity Coordinates - CIE 1976)

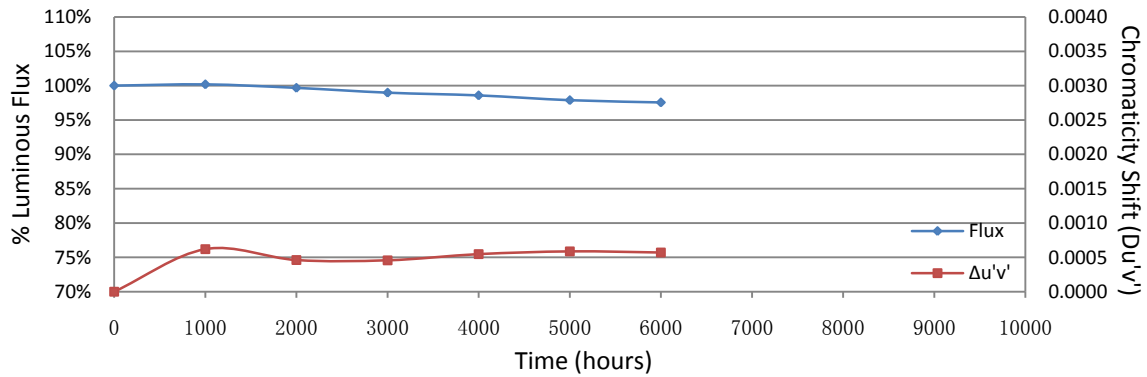
No.	Chromaticity Coordinates (CIE 1976)													
	0hr(Initial)		1000hrs		2000hrs		3000hrs		4000hrs		5000hrs		6000hrs	
	u'	v'	u'	v'	u'	v'	u'	v'	u'	v'	u'	v'	u'	v'
1	0.2452	0.5135	0.2446	0.5135	0.2448	0.5135	0.2448	0.5135	0.2448	0.5135	0.2447	0.5134	0.2450	0.5133
2	0.2445	0.5141	0.2434	0.5140	0.2440	0.5139	0.2442	0.5139	0.2442	0.5139	0.2451	0.5138	0.2451	0.5139
3	0.2445	0.5135	0.2439	0.5131	0.2438	0.5132	0.2441	0.5133	0.2441	0.5133	0.2437	0.5134	0.2439	0.5127
4	0.2445	0.5138	0.2440	0.5136	0.2439	0.5135	0.2442	0.5137	0.2442	0.5137	0.2448	0.5142	0.2451	0.5141
5	0.2447	0.5140	0.2442	0.5138	0.2440	0.5140	0.2442	0.5140	0.2442	0.514	0.2441	0.5138	0.2443	0.5142
6	0.2450	0.5140	0.2444	0.5139	0.2448	0.5141	0.2448	0.5138	0.2448	0.5138	0.2446	0.5147	0.2453	0.5143
7	0.2444	0.5140	0.2439	0.5135	0.2441	0.5137	0.2442	0.5135	0.2442	0.5135	0.2448	0.5145	0.2441	0.5138
8	0.2443	0.5139	0.2439	0.5139	0.2442	0.5139	0.2443	0.5135	0.2443	0.5135	0.2447	0.5141	0.2441	0.5144
9	0.2446	0.5141	0.2442	0.5141	0.2441	0.5141	0.2440	0.5142	0.244	0.5142	0.2441	0.5139	0.2440	0.5143
10	0.2451	0.5144	0.2446	0.5141	0.2449	0.5142	0.2448	0.5141	0.2448	0.5141	0.2454	0.5143	0.2456	0.5149
Ave.	0.2447	0.5139	0.2441	0.5138	0.2443	0.5138	0.2444	0.5138	0.2444	0.5138	0.2446	0.5140	0.2447	0.5140
Med.	0.2445	0.5139	0.2441	0.5139	0.2441	0.5139	0.2442	0.5138	0.2442	0.5138	0.2447	0.5140	0.2447	0.5142
st dev	0.0005	0.0002	0.0004	0.0003	0.0004	0.0003	0.0003	0.0003	0.0003	0.0003	0.0005	0.0004	0.0006	0.0006
Min.	0.2441	0.5135	0.2434	0.5131	0.2438	0.5132	0.2440	0.5133	0.2440	0.5133	0.2437	0.5134	0.2439	0.5127
Max.	0.2459	0.5144	0.2446	0.5141	0.2449	0.5142	0.2448	0.5142	0.2448	0.5142	0.2454	0.5147	0.2456	0.5149

3.5 Data Set 1, 85 °C, 360mA (Correlated Color Temperature)

No.	Correlated Color Temperature (K)						
	0hr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs
1	3199	3214	3209	3210	3210	3213	3204
2	3211	3245	3227	3223	3223	3199	3199
3	3217	3238	3239	3231	3231	3240	3241
4	3215	3232	3234	3224	3224	3204	3197
5	3207	3222	3228	3222	3222	3225	3218
6	3199	3218	3203	3207	3207	3205	3188
7	3217	3234	3228	3225	3225	3200	3226
8	3219	3231	3223	3224	3224	3205	3221
9	3208	3221	3223	3226	3226	3226	3224
10	3194	3208	3200	3204	3204	3186	3176
Ave.	3208	3226	3221	3220	3220	3210	3209
Med.	3212	3227	3225	3224	3224	3205	3211
st dev	14.1844	11.5571	13.0911	9.1311	9.1311	15.8889	19.8897
Min.	3174	3208	3200	3204	3204	3186	3176
Max.	3227	3245	3239	3231	3231	3240	3241

3.6 Data Set 1, 85 °C, 360mA (Chromaticity Shift)

No.	Chromaticity Shift ($\Delta u'v'$)					
	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs
1	0.0006	0.0004	0.0004	0.0005	0.0005	0.0003
2	0.0011	0.0005	0.0004	0.0007	0.0007	0.0006
3	0.0007	0.0008	0.0004	0.0006	0.0008	0.0010
4	0.0005	0.0007	0.0006	0.0005	0.0005	0.0007
5	0.0005	0.0007	0.0005	0.0006	0.0006	0.0004
6	0.0006	0.0002	0.0003	0.0005	0.0008	0.0004
7	0.0007	0.0004	0.0005	0.0005	0.0006	0.0004
8	0.0004	0.0001	0.0004	0.0007	0.0004	0.0005
9	0.0004	0.0005	0.0006	0.0004	0.0005	0.0006
10	0.0006	0.0003	0.0004	0.0004	0.0003	0.0007
Ave.	0.0006	0.0005	0.0005	0.0005	0.0006	0.0006
Med.	0.0006	0.0005	0.0004	0.0005	0.0006	0.0006
st dev	0.0002	0.0002	0.0001	0.0001	0.0002	0.0002
Min.	0.0004	0.0001	0.0003	0.0004	0.0003	0.0003
Max.	0.0011	0.0008	0.0006	0.0007	0.0008	0.0010



3.7 Data Set 2, 100 °C, 280mA (Lumen maintenance)

No.	VF	Φ(lm)	Lumen maintenance (%)					
	0hr(Initial)		1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs
1	35.36	1047	101.05	100.29	99.14	98.76	98.09	97.42
2	35.66	1046	99.52	99.04	98.18	97.90	97.51	97.13
3	35.59	1037	100.48	100.29	99.32	98.75	97.97	97.40
4	35.56	1042	99.90	99.52	98.75	98.37	97.70	97.12
5	35.56	1044	99.33	99.14	98.47	98.08	97.51	97.13
6	35.27	1083	99.72	99.54	98.61	98.15	97.60	97.32
7	35.25	1083	99.45	99.17	98.34	97.97	97.51	97.14
8	35.21	1081	100.19	99.44	98.61	98.15	97.69	97.22
9	35.24	1077	99.26	99.16	98.24	97.96	97.49	97.31
10	35.27	1079	99.72	99.54	98.89	98.52	97.87	97.31
Ave.	35.40	1062	99.86	99.51	98.66	98.26	97.69	97.25
Med.	35.32	1062	99.72	99.48	98.61	98.15	97.64	97.27
st dev	0.1746	19.9636	0.5657	0.0045	0.3779	0.3207	0.2152	0.1166
Min.	35.21	1037	99.26	99.04	98.18	97.90	97.49	97.12
Max.	35.66	1083	101.05	100.29	99.32	98.76	98.09	97.42

TM-21 Projection:

Test Duration: 6000 hours
Failures Observed: 0
 α : 5.483E-06
 β : 1.004
Calculated L70: 66,000
Reported L70: >33000

3.8 Data Set 2, 100 °C, 280mA (Luminous Flux)

No.	Luminous Flux (lm)						
	0hr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs
1	1047	1058	1050	1038	1034	1027	1020
2	1046	1041	1036	1027	1024	1020	1016
3	1037	1042	1040	1030	1024	1016	1010
4	1042	1041	1037	1029	1025	1018	1012
5	1044	1037	1035	1028	1024	1018	1014
6	1083	1080	1078	1068	1063	1057	1054
7	1083	1077	1074	1065	1061	1056	1052
8	1081	1083	1075	1066	1061	1056	1051
9	1077	1069	1068	1058	1055	1050	1048
10	1079	1076	1074	1067	1063	1056	1050
Ave.	1062	1060	1057	1048	1043	1037	1033
Med.	1062	1064	1059	1048	1045	1039	1034
st dev	19.9636	18.6559	18.6372	18.5544	18.4944	18.8633	19.5167
Min.	1037	1037	1035	1027	1024	1016	1010
Max.	1083	1083	1078	1068	1063	1057	1054

3.9 Data Set 2, 100 °C, 280mA (Chromaticity Coordinates - CIE 1931)

No.	Chromaticity Coordinates (CIE 1931)													
	0hr(Initial)		1000hrs		2000hrs		3000hrs		4000hrs		5000hrs		6000hrs	
	x	y	x	y	x	y	x	y	x	y	x	y	x	y
1	0.4201	0.3919	0.4204	0.3923	0.4202	0.3923	0.4206	0.3920	0.4208	0.3920	0.4206	0.3925	0.4203	0.3911
2	0.4223	0.3938	0.4200	0.3925	0.4204	0.3935	0.4211	0.3930	0.4231	0.3948	0.4217	0.3945	0.4214	0.3932
3	0.4229	0.3934	0.4211	0.3925	0.4221	0.3930	0.4220	0.3926	0.4234	0.3934	0.4226	0.394	0.4213	0.3927
4	0.4221	0.3932	0.4200	0.3926	0.4200	0.3927	0.4233	0.3936	0.4233	0.3935	0.4237	0.3948	0.4215	0.3936
5	0.4224	0.3939	0.4205	0.3930	0.4208	0.3934	0.4208	0.3931	0.4217	0.3929	0.4222	0.395	0.4210	0.3930
6	0.4205	0.3934	0.4191	0.3928	0.4192	0.3931	0.4193	0.3932	0.4192	0.3919	0.4199	0.3943	0.4196	0.3922
7	0.4203	0.3931	0.4188	0.3931	0.4189	0.3926	0.4192	0.3928	0.4189	0.3922	0.4204	0.3946	0.4192	0.3922
8	0.4204	0.3931	0.4204	0.3930	0.4202	0.3929	0.4202	0.3925	0.4206	0.3933	0.4209	0.3937	0.4213	0.3925
9	0.4204	0.3934	0.4191	0.3933	0.4196	0.3930	0.4197	0.3931	0.4205	0.3928	0.4211	0.3936	0.4202	0.3933
10	0.4197	0.3934	0.4195	0.3930	0.4197	0.3933	0.4199	0.3937	0.4190	0.3929	0.4201	0.394	0.4198	0.3937
Ave.	0.4216	0.3935	0.4199	0.3928	0.4201	0.3930	0.4206	0.3930	0.4211	0.3930	0.4213	0.3941	0.4206	0.3928
Med.	0.4221	0.3935	0.4200	0.3929	0.4201	0.3930	0.4204	0.3931	0.4207	0.3929	0.4210	0.3942	0.4207	0.3929
st dev	0.0010	0.0004	0.0007	0.0003	0.0009	0.0004	0.0013	0.0005	0.0018	0.0009	0.0012	0.0007	0.0008	0.0008
Min.	0.4197	0.3919	0.4188	0.3923	0.4189	0.3923	0.4192	0.3920	0.4189	0.3919	0.4199	0.3925	0.4192	0.3911
Max.	0.4229	0.3942	0.4211	0.3933	0.4221	0.3935	0.4233	0.3937	0.4234	0.3948	0.4237	0.3950	0.4215	0.3937

3.10 Data Set 2, 100 °C, 280mA (Chromaticity Coordinates - CIE 1976)

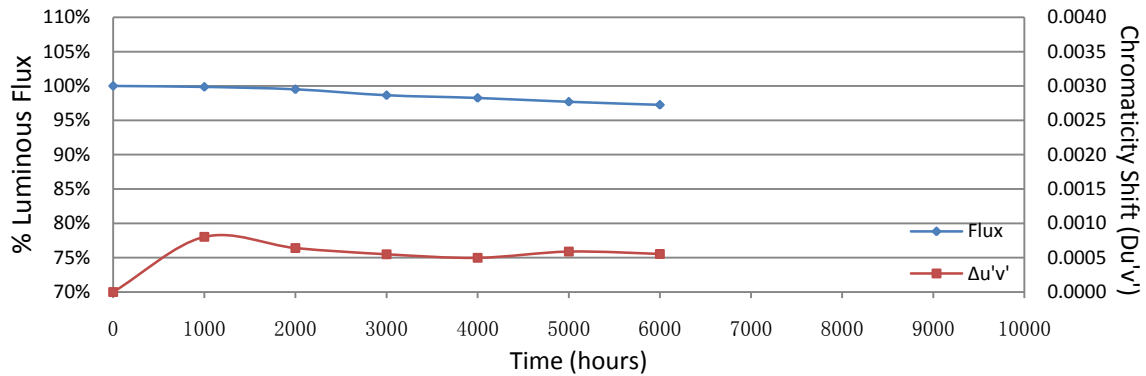
No.	Chromaticity Coordinates (CIE 1976)													
	0hr(Initial)		1000hrs		2000hrs		3000hrs		4000hrs		5000hrs		6000hrs	
	u'	v'	u'	v'	u'	v'	u'	v'	u'	v'	u'	v'	u'	v'
1	0.2449	0.5139	0.2449	0.5142	0.2448	0.5141	0.2451	0.5141	0.2453	0.5141	0.2449	0.5143	0.2453	0.5137
2	0.2455	0.5151	0.2445	0.5142	0.2444	0.5147	0.2450	0.5146	0.2455	0.5156	0.2448	0.5153	0.2451	0.5147
3	0.2460	0.5150	0.2453	0.5143	0.2457	0.5147	0.2458	0.5145	0.2464	0.5151	0.2456	0.5152	0.2453	0.5145
4	0.2456	0.5148	0.2445	0.5143	0.2445	0.5143	0.2462	0.5152	0.2463	0.5151	0.2460	0.5157	0.2451	0.5149
5	0.2455	0.5151	0.2446	0.5145	0.2447	0.5147	0.2448	0.5146	0.2455	0.5146	0.2450	0.5155	0.2450	0.5146
6	0.2445	0.5146	0.2438	0.5142	0.2437	0.5143	0.2438	0.5144	0.2443	0.5138	0.2437	0.5149	0.2444	0.5140
7	0.2445	0.5145	0.2435	0.5142	0.2438	0.5141	0.2439	0.5142	0.2440	0.5139	0.2439	0.5151	0.2441	0.5140
8	0.2446	0.5145	0.2446	0.5144	0.2445	0.5144	0.2447	0.5142	0.2446	0.5146	0.2446	0.5148	0.2454	0.5144
9	0.2445	0.5146	0.2436	0.5144	0.2440	0.5143	0.2441	0.5144	0.2447	0.5144	0.2448	0.5148	0.2443	0.5146
10	0.2439	0.5145	0.2440	0.5143	0.2440	0.5145	0.2440	0.5147	0.2437	0.5142	0.2440	0.5148	0.2439	0.5147
Ave.	0.2452	0.5148	0.2443	0.5143	0.2444	0.5144	0.2447	0.5145	0.2450	0.5145	0.2447	0.5150	0.2448	0.5144
Med.	0.2454	0.5149	0.2445	0.5143	0.2445	0.5144	0.2448	0.5145	0.2450	0.5145	0.2448	0.5150	0.2451	0.5146
st dev	0.0005	0.0003	0.0006	0.0001	0.0006	0.0002	0.0008	0.0003	0.0009	0.0006	0.0007	0.0004	0.0006	0.0004
Min.	0.2439	0.5139	0.2435	0.5142	0.2437	0.5141	0.2438	0.5141	0.2437	0.5138	0.2437	0.5143	0.2439	0.5137
Max.	0.2460	0.5153	0.2453	0.5145	0.2457	0.5147	0.2462	0.5152	0.2464	0.5156	0.2460	0.5157	0.2454	0.5149

3.11 Data Set 2, 100 °C, 280mA (Correlated Color Temperature)

No.	Correlated Color Temperature (K)						
	0hr(Initial)	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs
1	3203	3200	3204	3195	3191	3199	3193
2	3178	3211	3211	3194	3171	3194	3190
3	3163	3188	3174	3173	3152	3174	3187
4	3176	3212	3211	3157	3155	3159	3190
5	3176	3205	3203	3200	3180	3188	3196
6	3208	3232	3232	3230	3222	3228	3216
7	3209	3239	3232	3228	3229	3220	3225
8	3207	3207	3210	3207	3206	3204	3185
9	3209	3235	3224	3221	3203	3198	3214
10	3224	3224	3223	3223	3234	3221	3225
Ave.	3187	3215	3212	3203	3194	3199	3202
Med.	3180	3212	3211	3204	3197	3199	3195
st dev	16.5664	16.6270	17.1866	24.1836	29.5374	21.5006	16.0447
Min.	3163	3188	3174	3157	3152	3159	3185
Max.	3224	3239	3232	3230	3234	3228	3225

3.12 Data Set 2, 100 °C, 280mA (Chromaticity Shift)

No.	Chromaticity Shift ($\Delta u'v'$)					
	1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs
1	0.0003	0.0002	0.0003	0.0004	0.0004	0.0004
2	0.0013	0.0012	0.0007	0.0005	0.0007	0.0006
3	0.0010	0.0004	0.0005	0.0004	0.0004	0.0009
4	0.0012	0.0012	0.0007	0.0008	0.0010	0.0005
5	0.0011	0.0009	0.0009	0.0005	0.0006	0.0007
6	0.0008	0.0009	0.0007	0.0008	0.0009	0.0006
7	0.0010	0.0008	0.0007	0.0008	0.0008	0.0006
8	0.0001	0.0001	0.0003	0.0001	0.0003	0.0008
9	0.0009	0.0006	0.0004	0.0003	0.0004	0.0002
10	0.0002	0.0001	0.0002	0.0004	0.0003	0.0002
Ave.	0.0008	0.0006	0.0005	0.0005	0.0006	0.0006
Med.	0.0010	0.0007	0.0006	0.0005	0.0005	0.0006
st dev	0.0004	0.0004	0.0002	0.0002	0.0003	0.0002
Min.	0.0001	0.0001	0.0002	0.0001	0.0003	0.0002
Max.	0.0013	0.0012	0.0009	0.0008	0.0010	0.0009



Appendix A – EUT PHOTO

A.1 Mechanical Dimensions (Ta = 25 °C)

A.2 EUT Photo

