

Report Number: ICE-LM80-003

November 2, 2011

*Bridgelux LM80 Report: 6,500 Hour Test Data
Bridgelux RS LED Array BXRA – W3000*

Contents:

Number of LED light Sources tested	2
Description of LED light sources	2
Description of Auxiliary Equipment	2
Operating Cycle	3
Test Condition.....	3
Ambient Conditions	3
Airflow	3
Physical condition of parts at read-points	3
Case Temperature (Test Point Temperature)	3
Drive Current.....	3
Initial Flux and Forward Voltage at Photometric Measurement Current	4
Lumen Maintenance	5
Observation of Failures.....	8
LED Light Source monitoring interval	8
Photometric Measurement Uncertainty	8
Gauge study results	8
Chromaticity Shift.....	9

Number of LED light sources tested

A first-party EPA-recognized laboratory for the ENERGY STAR® program

- 10 arrays tested at actual case temperature 55°C (nominal 55°C)
- 10 arrays tested at actual case temperature 85°C (nominal 85°C)
- 10 arrays tested at actual case temperature 105°C (nominal 105°C)

Samples have been selected to be representative of the overall population being tested. AQL “Zero Based Acceptance Sampling Plan” has been used to pick samples from a typical lot size of 250 units. The AQL level is 4%.

Description of LED light sources

- Bridgelux LED array, BXRA-W3000
- Color Temperature: 3000K

This report also covers the following ES Rectangle Series products:

Warm White: 2700K, 3000K, 3500K

BXRA-W0802, BXRA-W1202, BXRA-W1203, BXRA-1800, BXRA-27E0800, BXRA-27G0800, BXRA-27E1200, BXRA-27G1200, BXRA-27E2000, BXRA-27G2000, BXRA-30E0800, BXRA-30G0800, BXRA-30E1200, BXRA-30G1200, BXRA-30E2000, BXRA-30G2000, BXRA-35E0800, BXRA-35E1200, BXRA-35E2000,

Neutral White: 4000K

BXRA-N0802, BXRA-N1203, BXRA-N2000, BXRA-40E0950, BXRA-40E1350, BXRA-40E2200

Cool White: 5000K, 5600K

BXRA-C0802, BXRA-C1202, BXRA-C2002, BXRA-C2500, BXRA-50C1100, BXRA-50C1600, BXRA-50C2600, BXRA-56C1100, BXRA-56C1600, BXRA-56C2600

Description of Auxiliary Equipment

- Tester: Automatic LED array tester
- Temperature controlled ovens to create the necessary test conditions
- Arrays driven using constant current driver

Array tester: The tester is capable of testing an entire board with up to 12 samples. The tester consists of a spectrometer, handler, power supplies and a computer.

Sample preparation: Devices under Test (DUT) are soldered to PCBs which are mounted on metallic plates. These plates are mounted on heat sinks to maintain the test temperatures required by LM80 test procedure.

All necessary steps are taken to ensure the uniformity of temperature and environmental conditions to meet LM80 test criteria.

Operating Cycle

Test Condition

Number of units: 10 at 55°C, 10 at 85°C and 10 at 105°C.
 Drive current: 2100mA, per array
 Typical Voltage: 25.6V

Ambient Conditions

Summary of temperature and humidity conditions:

Table 1: Test Environment

Surrounding Temperature	Actual Case Temperature	Nominal Case Temperature	Relative Humidity
53°C	55°C	55°C	7.9%
83°C	85°C	85°C	3.4%
103°C	105°C	105°C	2.8%

Airflow

Note: Airflow is kept to minimum required to maintain the required temperature uniformity as defined in the LM80 requirements document.

The temperature of the air surrounding DUTs is controlled to be less than 5°C below the case temperature as required by LM80 specification.

Physical condition of parts at read-points

- No cracks
- No discoloration
- No electrical discontinuity

Case Temperature (Test Point Temperature)

Refer to Table 1 (Test Environment)

Drive Current

A drive current of 262.5mA per diode was used during lifetime test.

Table 2: Initial Flux and Forward Voltage at Photometric Measurement

Current

Ambient temperature during lumen and chromaticity measurements was maintained at 25°C ±2°C

First set (samples tested at actual case temperature 55°C)

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Median	Standard Deviation	Max	Min
Initial Flux	3562.00	3603.00	3649.00	3565.00	3470.00	3684.00	3609.00	3632.00	3604.00	3552.00	3603.50	59.60	3684.00	3470.00
Forward Voltage	25.92	25.99	25.93	25.75	26.03	25.73	25.59	25.57	25.62	25.75	25.75	0.17	26.03	25.57

Second set (samples tested at actual case temperature 85°C)

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Median	Standard Deviation	Max	Min
Initial Flux	3564.00	3600.00	3629.00	3682.00	3545.00	3448.00	3660.00	3566.00	3629.00	3680.00	3614.50	72.25	3682.00	3448.00
Forward Voltage	25.90	25.73	25.79	25.68	25.97	26.03	25.60	25.71	25.79	25.76	25.78	0.13	26.03	25.60

Third set (samples tested at actual case temperature 105°C)

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Median	Standard Deviation	Max	Min
Initial Flux	3563.00	3611.00	3564.00	3637.00	3627.00	3642.00	3502.00	3364.00	3689.00	3596.00	3603.50	91.70	3689.00	3364.00
Forward Voltage	25.74	25.75	25.92	25.88	25.94	25.98	26.02	26.06	25.60	25.62	25.90	0.16	26.06	25.60

Lumen Maintenance

Ambient temperature during lumen measurements was maintained at 25°C ±2°C

Table 3: Lumen Maintenance at actual case temperature 55°C

Hours	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Median	Standard Deviation	Max	Min
0	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	0.00%	100.00%	100.00%
1000	100.91%	100.86%	100.52%	101.01%	100.35%	99.95%	100.28%	100.15%	100.62%	99.93%	100.43%	0.39%	101.01%	99.93%
2000	101.82%	101.72%	101.04%	102.02%	100.69%	99.89%	100.55%	100.30%	101.25%	99.86%	100.87%	0.78%	102.02%	99.86%
3000	96.69%	99.78%	98.79%	97.59%	104.64%	99.08%	99.83%	102.37%	102.28%	102.53%	99.81%	2.51%	104.64%	96.69%
4000	98.09%	97.67%	93.53%	100.00%	103.40%	97.29%	100.36%	97.16%	98.97%	99.01%	98.53%	2.56%	103.40%	93.53%
5000	101.07%	98.75%	94.46%	101.32%	104.55%	99.05%	100.97%	98.60%	99.50%	103.04%	100.24%	2.77%	104.55%	94.46%
6000	97.04%	98.71%	94.70%	100.17%	103.61%	98.68%	101.16%	98.16%	100.09%	101.93%	99.40%	2.55%	103.61%	94.70%
6500	96.87%	96.17%	92.83%	98.40%	101.35%	94.54%	100.00%	95.51%	97.98%	100.57%	97.43%	2.75%	101.35%	92.83%

Figure 1: Lumen Maintenance at actual case temperature 55°C

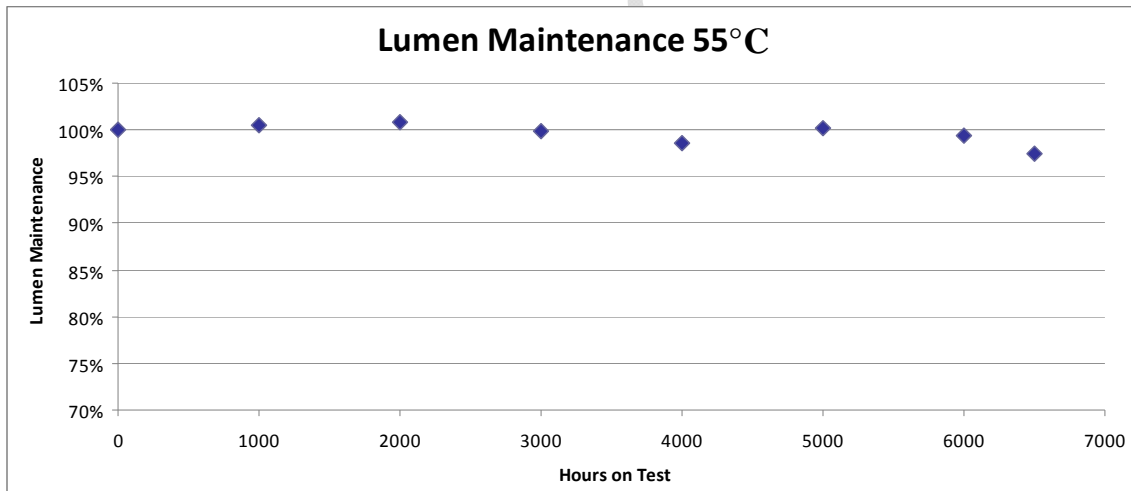


Table 4: Lumen Maintenance at actual case temperature 85°C

Hours	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Median	Standard Deviation	Max	Min
0	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	0.00%	100.00%	100.00%
1000	99.00%	98.97%	98.50%	98.15%	98.79%	99.85%	98.57%	99.49%	100.19%	98.93%	98.95%	0.63%	100.19%	98.15%
2000	98.70%	98.65%	97.95%	97.42%	98.39%	99.97%	98.05%	99.43%	100.49%	98.60%	98.63%	0.95%	100.49%	97.42%
3000	98.39%	98.34%	97.40%	96.69%	97.98%	100.10%	97.54%	99.38%	100.79%	98.27%	98.30%	1.26%	100.79%	96.69%
4000	98.15%	98.24%	97.77%	96.71%	97.68%	101.02%	97.69%	99.83%	101.08%	99.73%	98.19%	1.52%	101.08%	96.71%
5000	97.29%	97.50%	95.55%	95.21%	102.85%	100.32%	90.01%	96.92%	95.55%	94.23%	96.24%	3.45%	102.85%	90.01%
6000	96.28%	95.98%	96.12%	94.50%	96.14%	99.09%	96.80%	97.97%	100.25%	98.62%	96.54%	1.75%	100.25%	94.50%
6500	96.94%	96.33%	95.55%	95.14%	95.89%	100.60%	95.29%	99.13%	101.01%	97.69%	96.63%	2.18%	101.01%	95.14%

Figure 2: Lumen Maintenance at actual case temperature 85°C

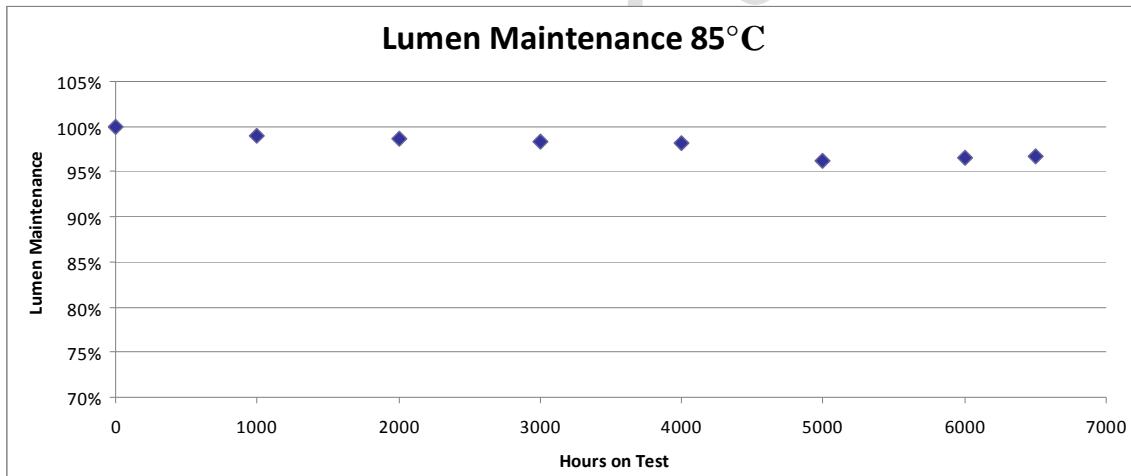
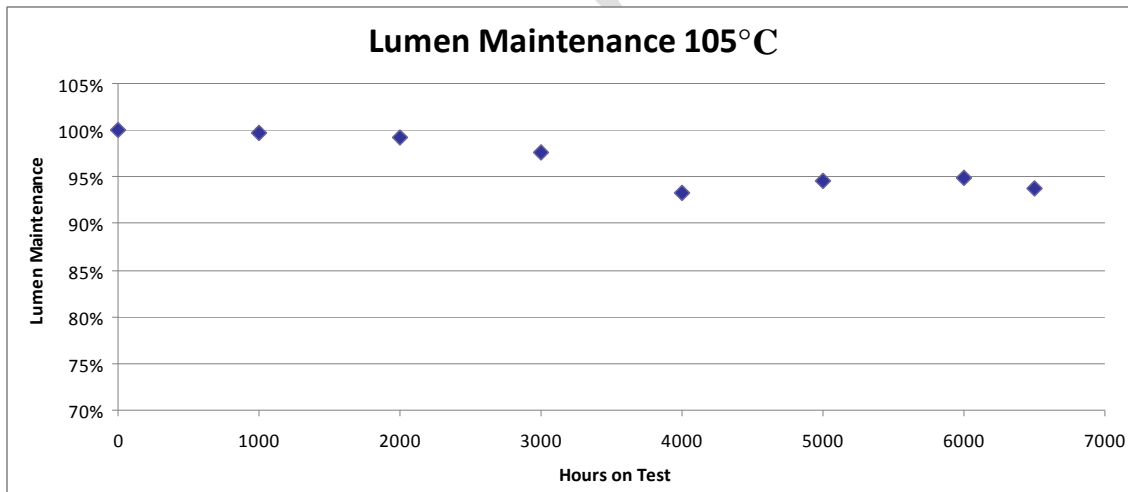


Table 5: Lumen Maintenance at actual case temperature 105°C

Hours	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Median	Standard Deviation	Max	Min
0	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	0.00%	100.00%	100.00%
1000	99.18%	100.50%	99.88%	99.05%	99.81%	99.84%	99.02%	99.73%	99.56%	99.41%	99.65%	0.45%	100.50%	99.02%
2000	98.36%	100.99%	99.76%	98.11%	99.61%	99.67%	98.03%	99.46%	99.12%	98.83%	99.29%	0.91%	100.99%	98.03%
3000	91.52%	93.36%	98.96%	93.75%	94.31%	97.36%	97.74%	104.59%	97.76%	99.73%	97.55%	3.82%	104.59%	91.52%
4000	89.00%	90.22%	92.26%	93.24%	93.47%	90.31%	95.72%	98.63%	94.23%	94.23%	93.35%	2.86%	98.63%	89.00%
5000	89.88%	91.92%	93.95%	94.77%	97.18%	93.60%	97.77%	99.15%	94.36%	96.86%	94.56%	2.83%	99.15%	89.88%
6000	90.89%	92.29%	94.74%	93.68%	97.30%	93.42%	96.66%	98.27%	95.11%	97.34%	94.92%	2.42%	98.27%	90.89%
6500	88.15%	91.42%	95.31%	90.73%	95.60%	91.30%	95.20%	95.22%	92.96%	94.57%	93.76%	2.55%	95.60%	88.15%

Figure 3 Lumen Maintenance at actual case temperature 105°C



Observation of Failures

No optical, electrical or mechanical failure of any LED array was seen during the lifetime testing.

LED Light Source monitoring interval

Measurements have been taken after the following durations:

T_c = 55°C:

0, 1000, 2000, 3000, 4000, 5000 and 6000 hours.

T_c = 85°C:

0, 1000, 2000, 3000, 4000, 5000 and 6000 hours.

T_c = 105°C:

0, 1000, 2000, 3000, 4000, 5000 and 6000 hours.

Photometric Measurement Uncertainty

The testers are calibrated monthly and the calibration data ensures <1% uncertainty of measurement.

Gauge Study Results

Gauge study shows the following results:

R&R:	0.15% (5.15-sigma)
Standard Deviation:	0.03%

Chromaticity Shift

Ambient temperature during chromaticity measurements was maintained at 25°C ±2°C

Table 6: Chromaticity shift (Duv) at actual case temperature 55°C

Hours	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Median	Standard Deviation	Max	Min
0	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1000	0.00029	0.00025	0.00031	0.00167	0.00030	0.00035	0.00036	0.00040	0.00038	0.00037	0.00036	0.00042	0.00167	0.00025
2000	0.00058	0.00050	0.00061	0.00334	0.00060	0.00070	0.00073	0.00080	0.00075	0.00073	0.00072	0.00085	0.00334	0.00050
3000	0.00192	0.00319	0.00472	0.00297	0.00320	0.00123	0.00374	0.00283	0.00321	0.00305	0.00312	0.00094	0.00472	0.00123
4000	0.00193	0.00330	0.00338	0.00354	0.00022	0.00420	0.00278	0.00366	0.00446	0.00175	0.00334	0.00129	0.00446	0.00022
5000	0.00219	0.00330	0.00301	0.00309	0.00039	0.00416	0.00270	0.00310	0.00478	0.00179	0.00305	0.00122	0.00478	0.00039
6000	0.00221	0.00352	0.00289	0.00310	0.00033	0.00395	0.00294	0.00330	0.00505	0.00226	0.00302	0.00124	0.00505	0.00033
6500	0.00232	0.00347	0.00314	0.00327	0.00021	0.00420	0.00285	0.00374	0.00477	0.00224	0.00321	0.00126	0.00477	0.00021

Figure 4: Chromaticity shift (Duv) at actual case temperature 55°C

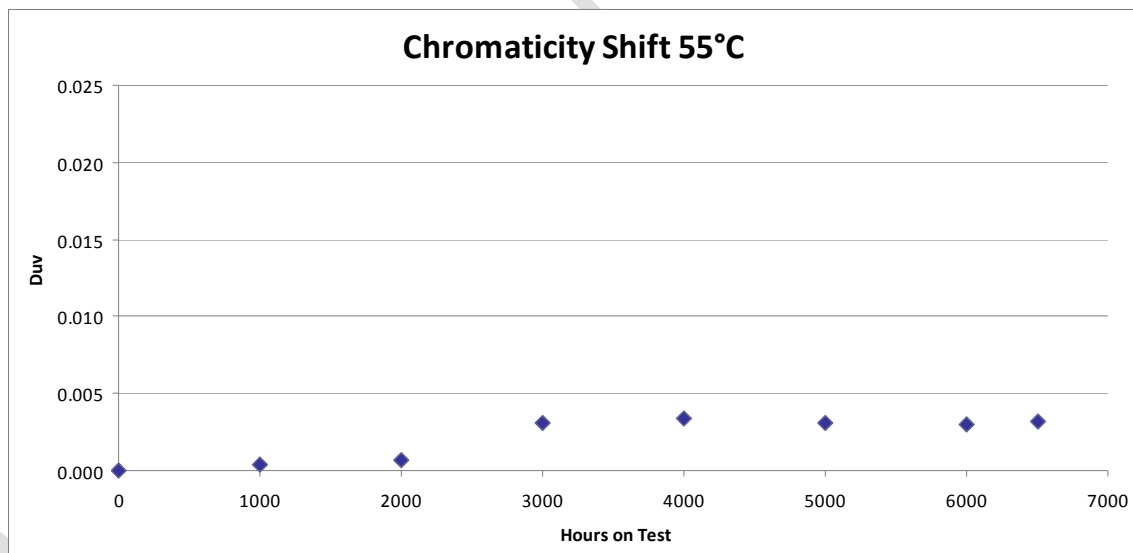


Table 6: Chromaticity Shift at actual case temperature 85°C

Hours	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Median	Standard Deviation	Max	Min
0	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1000	0.00101	0.00117	0.00110	0.00122	0.00088	0.00102	0.00106	0.00092	0.00164	0.00106	0.00106	0.00021	0.00164	0.00088
2000	0.00152	0.00176	0.00166	0.00183	0.00132	0.00153	0.00158	0.00137	0.00245	0.00158	0.00158	0.00032	0.00245	0.00132
3000	0.00203	0.00235	0.00221	0.00244	0.00177	0.00203	0.00212	0.00183	0.00326	0.00212	0.00212	0.00042	0.00326	0.00177
4000	0.00210	0.00233	0.00249	0.00253	0.00171	0.00220	0.00227	0.00181	0.00352	0.00216	0.00224	0.00050	0.00352	0.00171
5000	0.00196	0.00261	0.00330	0.00375	0.00434	0.00299	0.00103	0.00472	0.00243	0.00168	0.00280	0.00118	0.00472	0.00103
6000	0.00304	0.00358	0.00309	0.00321	0.00302	0.00206	0.00328	0.00222	0.00338	0.00263	0.00306	0.00050	0.00358	0.00206
6500	0.00373	0.00399	0.00353	0.00409	0.00371	0.00198	0.00364	0.00275	0.00338	0.00343	0.00358	0.00063	0.00409	0.00198

Figure 5: Chromaticity Shift (Duv) at actual case temperature 85°C

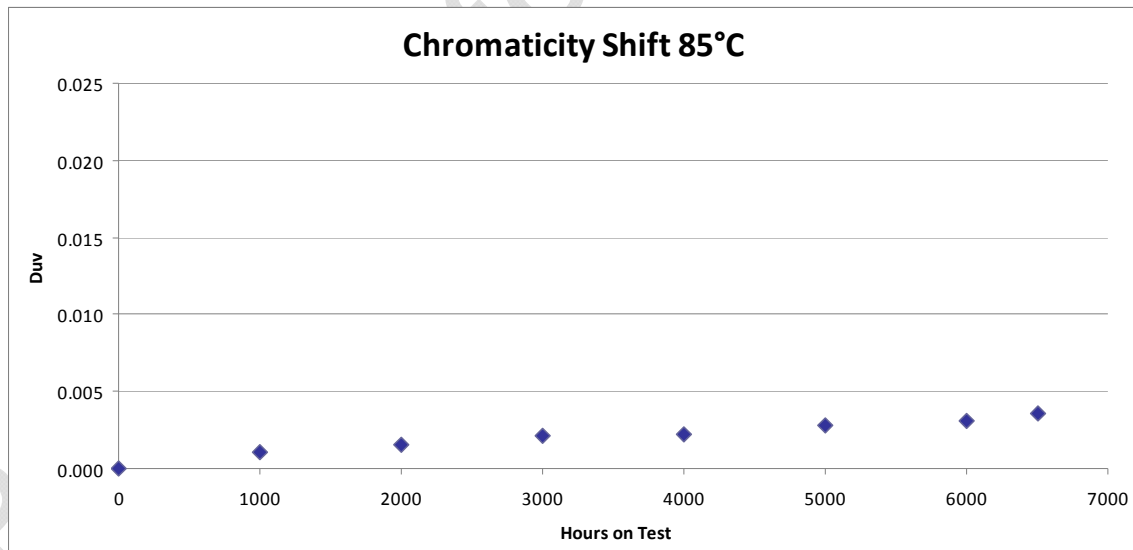
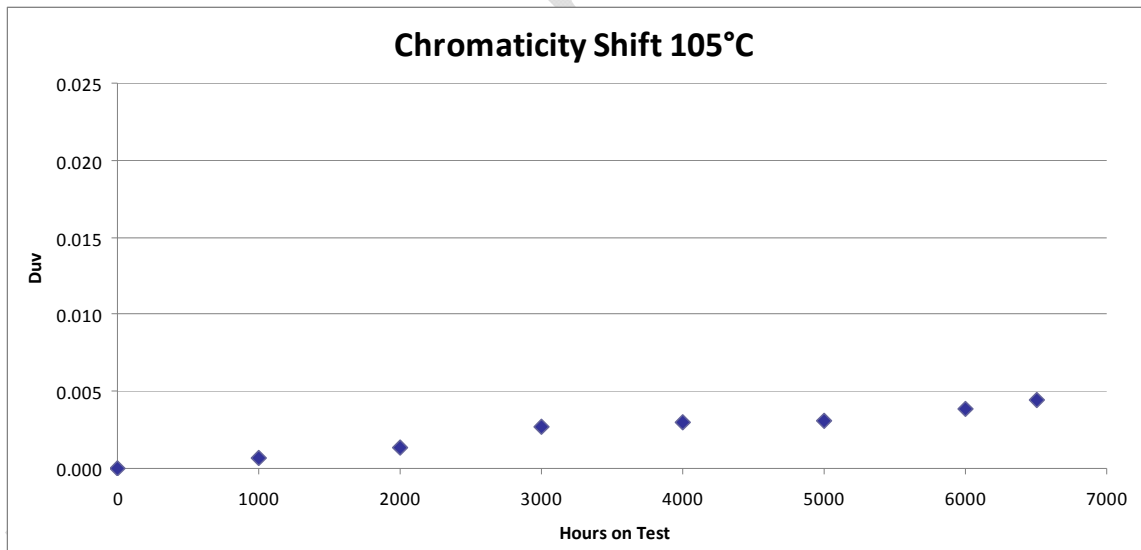


Table 7: Chromaticity Shift at actual case temperature 105°C

Hours	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10	Median	Standard Deviation	Max	Min
0	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1000	0.00101	0.00062	0.00066	0.00101	0.00055	0.00066	0.00072	0.00058	0.00074	0.00096	0.00069	0.00018	0.00101	0.00055
2000	0.00203	0.00123	0.00132	0.00203	0.00110	0.00133	0.00145	0.00116	0.00149	0.00193	0.00139	0.00036	0.00203	0.00110
3000	0.00711	0.00357	0.00589	0.00200	0.00233	0.00272	0.00297	0.00079	0.00250	0.00262	0.00267	0.00188	0.00711	0.00079
4000	0.00730	0.00323	0.00251	0.00672	0.00243	0.00302	0.00124	0.00320	0.00303	0.00271	0.00303	0.00192	0.00730	0.00124
5000	0.00796	0.00408	0.00284	0.00646	0.00238	0.00358	0.00244	0.00229	0.00326	0.00295	0.00311	0.00190	0.00796	0.00229
6000	0.00887	0.00409	0.00396	0.00753	0.00286	0.00401	0.00280	0.00266	0.00379	0.00371	0.00388	0.00208	0.00887	0.00266
6500	0.0094103	0.004348	0.007679	0.0054399	0.0033767	0.004699	0.0030681	0.0031048	0.0042655	0.0045143	0.00443	0.00206	0.00941	0.00307

Figure 6: Chromaticity shift (Duv) at actual case temperature 105°C



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