



LM-80-08

TEST AND MEASUREMENT REPORT (10000 HRS)

For

Xicato, Inc.

101 Daggett Dr.
San Jose, CA 95134, USA

Model: XCA19803030CCA

Report Type: Original Report		Product Type: LED Module	
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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R1405227-10000 Hours	Original Report	2016-02-16

1 GENERAL INFORMATION

1.1 Product Description for Equipment Under Test (EUT)

The Xicato LED module model XCA19803030CCA is used for light source. The module is an enclosed COB with sealed silicon aperture mounted on a round aluminum base.

The LED module model XCA19803030CCA has the following photometric characteristics:

- a) Target Correlated Color Temperature (CCT): 3000K.
- b) Total luminous flux: Approximately 3000 lumens.
- c) Color Rendering Index (CRI): Above 80.

1.2 Sampling Method

The samples were randomly gathered by the manufacturer and distributed to the BACL Laboratory for testing.

1.3 Number of Samples

A total of 26 LED modules were used for 6000 hours testing which were divided into 13 samples for 90°C and 13 samples for 55°C LM-80 elevated temperature stressed test.

1.4 Electrical and Mechanical Description of the EUT

Listed Wattage	Listed Current	LED Type	Dimensions (mm)	Manufacturer	Model Number
29.3W	1.05A	LED Module	28.6 (L) x 23.3 (W) x 5.5 (H)	XICATO, Inc.	XCA19803030CCA

1.5 Product Family

The tested product model XCA19803030CCA is constructed as COB (Chip On Board) with one common phosphor layer overlaying all dies, and satisfies the conditions set forth in Section 3.7 of the ENERGY STAR Program Guidance Regarding LED Package, LED Array and LED Module Lumen Maintenance Performance Data Supporting Qualification of Lighting Products Sept 9 2011 for equivalent product models to be qualified as Energy Star products as described in the table below.

Type	Product Family	Module Part Number	# of LEDs	Minimum Die Spacing (mm)	Maximum Power Density (W/mm ²)
Tested Module	XCA	XCA19803030CCA	30 (3x10)	0.2	32.6
Equivalent Modules	XCA	XCA1980ZZ13CCA	12 (2x6)	0.2	32.6
		XCA1980ZZ20CCA	20 (2x10)	0.2	32.6
		XCA1980ZZ30CCA	30 (3x10)	0.2	32.6
		XCA19V8ZZ13CCA	12 (2x6)	0.2	32.6
		XCA19V8ZZ20CCA	20 (2x10)	0.2	32.6
		XCA19V8ZZ30CCA	30 (3x10)	0.2	32.6
		XCA1995ZZ13CCA	16 (2x8)	0.2	32.6
		XCA1995ZZ20CCA	27 (3x9)	0.2	32.6
		XCA19V9ZZ13CCA	16 (2x8)	0.2	32.6
		XCA19V9ZZ20CCA	27 (3x9)	0.2	32.6
	XTM	XTM1980ZZ13CCA	12 (2x6)	0.2	32.6
		XTM1980ZZ20CCA	20 (2x10)	0.2	32.6
		XTM1980ZZ30CCA	30 (3x10)	0.2	32.6
		XTM19V8ZZ13CCA	12 (2x6)	0.2	32.6
		XTM19V8ZZ20CCA	20 (2x10)	0.2	32.6
		XTM19V8ZZ30CCA	30 (3x10)	0.2	32.6
		XTM1995ZZ13CCA	16 (2x8)	0.2	32.6
		XTM1995ZZ20CCA	27 (3x9)	0.2	32.6
		XTM19V9ZZ13CCA	16 (2x8)	0.2	32.6
		XTM19V9ZZ20CCA	27 (3x9)	0.2	32.6
	XIM	XIM1980ZZ13A2A	12 (2x6)	0.2	32.6
		XIM1980ZZ20A2A	20 (2x10)	0.2	32.6
		XIM1980ZZ13A3A	12 (2x6)	0.2	32.6
		XIM1980ZZ20A3A	20 (2x10)	0.2	32.6
		XIM19V8ZZ13A2A	12 (2x6)	0.2	32.6
		XIM19V8ZZ20A2A	20 (2x10)	0.2	32.6
		XIM19V8ZZ13A3A	12 (2x6)	0.2	32.6
		XIM19V8ZZ20A3A	20 (2x10)	0.2	32.6
		XIM1995ZZ13A2A	16 (2x8)	0.2	32.6
		XIM1995ZZ13A3A	16 (2x8)	0.2	32.6
XIM19V9ZZ13A2A		16 (2x8)	0.2	32.6	
XIM19V9ZZ13A3A		16 (2x8)	0.2	32.6	
	ZZ	27 (2700 K), 30 (3000 K), 35 (3500 K) or 40 (4000 K)			

1.6 Objective

The objective of this test report is to demonstrate the product model XCA19803030CCA meets the requirements for LED module as required by the Energy Star Program Requirements, Product Specification for Luminaires (Light Fixtures) Eligibility Criteria Ver. 2.0.

1.7 Test Method

1.7.1 Standards

The test report is prepared on behalf of XICATO, Inc. in accordance with the following American National Standards, International Commission on Illumination, and Illumination Engineering Society of North America:

- IESNA TM-16-05 Technical Memorandum on Light Emitting Diode (LED) Sources and Systems
- CIE 15-2004 Colorimetry, 3rd edition.
- ANSI C78.377-2008 Specifications of the Chromaticity of Solid State Lighting Products.
- IESNA LM-78-2007 Approved Method for Total Luminous Flux Measurement of Lamps Using an Integrating Sphere Photometer
- IESNA LM-58-94 Guide to Spectroradiometric Measurements
- CIE 63-1984 Spectroradiometric Measurement of Light Sources
- CIE 13.3-1995 Method of Measuring and Specifying Color Rendering of Light Sources
- IES LM-79-08 Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products (Not to include Sec 9.2 and 10.0 for Luminous Intensity)
- IES LM-80-08 Approved Method: Measuring Lumen Maintenance of LED Light Sources

1.7.2 Lumen Maintenance, Testing Duration and Interval

The testing duration was 10000 hours with the initial measurement at 0 hour. The interval measurement was 1000 hours.

1.7.3 Operating Cycle

There was no operating cycle to the tested LED samples. The LEDs were turned on continuously for each 1000 hours interval.

1.7.4 Drive Current during Lifetime Test

Each sample of the LED modules was powered by an individual Mean Well power supply model LPC-60-1050 to provide 30Vdc of typical voltage and 1.05Amp of drive current. The Mean Well power supplies were in turn powered at the regulated 120Vac by the Behlman AC Power Source. The voltage, frequency, and Total Harmonic Distortion of the AC source were monitored and logged by the BMI Data Logger.

1.7.5 Case Temperature Measurement Point

The Case Temperature for each sample of the LED module during the temperature stressed test was measured and logged by the Yokogawa Hybrid Recorder. Type T thermocouple was used and was attached to the “hot spot” located on the side of the LED metal wall enclosure as specified by the manufacturer. Case temperatures were controlled to not less than minus 2°C of the tested temperatures of 90°C and 55°C.

1.7.6 Uncertainty

The photometric measurement was performed by the Labsphere Diode Array DAS-1100 and the 1.5m Everfine Integrating Sphere System. The total uncertainty of the light output measurement was estimated, at the 95% confidence level, not to exceed $\pm 3.8\%$ over the wavelength range of 390 nm to 760 nm.

1.8 Test Facility

Bay area compliance Laboratories Corp. (BACL) is:

1- An independent Commercial Test Laboratory accredited to **ISO 17025:2005** by **A2LA**, in the fields of: Electromagnetic Compatibility & Telecommunications covering Emissions, Immunity, Radio, RF Exposure, Safety and Telecom. This includes NEBS (Network Equipment Building System), Wireless RF, Telecommunications Terminal Equipment (TTE); Network Equipment; Information Technology Equipment (ITE); Medical Electrical Equipment; Industrial, Commercial, and Medical Test Equipment; Professional Audio and Video Equipment; Electronic (Digital) Products; Industrial and Scientific Instruments; Cabled Distribution Systems and Energy Efficiency Lighting.

2- An ENERGY STAR Recognized Laboratory, for the LM80 Testing, a wide variety of Luminaires and Computers.

3- A NIST Designated Phase-I and Phase-II CAB including: ACMA (Australian Communication and Media Authority), BSMI (Bureau of Standards, Metrology and Inspection of Taiwan), IDA (Infocomm Development Authority of Singapore), IC(Industry Canada), Korea (Ministry of Communications Radio Research Laboratory), NCC (Formerly DGT; Directorate General of Telecommunication of Chinese Taipei) OFTA (Office of the Telecommunications Authority of Hong Kong), Vietnam, VCCI - Voluntary Control Council for Interference of Japan and a designated EU CAB (Conformity Assessment Body) (Notified Body) for the EMC and R&TTE Directives.

4- A Product Certification Body accredited to **ISO Guide 65:1996** by **A2LA** to certify:

1. Unlicensed, Licensed radio frequency devices and Telephone Terminal Equipment for the FCC. Scope A1, A2, A3, A4, B1, B2, B3, B4 & C.

2. Radio Standards Specifications (RSS) in the Category I Equipment Standards List and All Broadcasting Technical Standards (BETS) in Category I Equipment Standards List for Industry Canada.

3. Radio Communication Equipment for Singapore.

4. Radio Equipment Specifications, GMDSS Marine Radio Equipment Specifications, and Fixed Network Equipment Specifications for Hong Kong.

5. Japan MIC Telecommunication Business Law (A1, A2) and Radio Law (B1, B2 and B3).

6. Audio/Video, Battery Charging Systems, Computers, Displays, Enterprise Servers, Imaging Equipment, Set-Top Boxes, Telephony, Televisions, Ceiling Fans, CFLs (Including GU24s), Decorative Light Strings, Integral LED Lamps, Luminaires, Residential Ventilating Fans.

The test site used by BAACL Corp. to collect radiated and conducted emissions measurement data is located at its facility in Sunnyvale, California, USA.

The test site at BAACL Corp. has been fully described in reports submitted to the Federal Communication Commission (FCC) and Voluntary Control Council for Interference (VCCI). The details of these reports have been found to be in compliance with the requirements of Section 2.948 of the FCC Rules on February 11 and December 10, 1997, and Article 8 of the VCCI regulations on December 25, 1997. The test site also complies with the test methods and procedures set forth in CISPR 22:2008 §10.4 for measurements below 1 GHz and §10.6 for measurements above 1 GHz as well as ANSI C63.4-2009, ANSI C63.4-2009, TIA/EIA-603 & CISPR 24:2010.

The Federal Communications Commission and Voluntary Control Council for Interference have the reports on file and they are listed under FCC registration number: 90464 and VCCI Registration No.: A-0027. The test site has been approved by the FCC and VCCI for public use and is listed in the FCC Public Access Link (PAL) database.

Additionally, BAACL Corp. is an American Association for Laboratory Accreditation (A2LA) accredited laboratory (Lab Code 3297-02). The current scope of accreditations can be found at <http://www.a2la.org/scopepdf/3297-02.pdf?CFID=1132286&CFTOKEN=e42a3240dac3f6ba-6DE17DCB-1851-9E57-477422F667031258&jsessionid=8430d44f1f47cf2996124343c704b367816b>

1.9 Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
BACL	Elevated Temperature Stress Test Chamber	/	/	N/A	N/A
Dickson	Temperature & Humidity Chart Recorder	THDX	03188533	2015-03-05	2017-03-05
Yokogawa	Hybrid Recorder (60 Channels)	DR242	48JD0017	2015-03-30	2016-03-30
Labsphere	Diode Array	DAS-1100	5795	Within calibration	Within calibration
Everfine	Integrating sphere	1.5m	0111466	Within calibration	Within calibration
Everfine	Power Supply for Standard Lamp and LED Module	WY305	809024	See Note	See Note
Labsphere	Standard Lamp	SLC-1400	J101, K101, L101	2012-02-02	Within manufacturer 100 hours of use
MeanWell	AC-DC Power Adaptor	LPC-60-1050	N/A	N/A	N/A
Fluke	True RMS Multimeter, for Voltage Measurement	179	78490059	2015-07-06	2016-07-06
Fluke	True RMS Multimeter, for Current Measurement	189	89920092	2015-02-19	2016-02-19
BACL	LED Electrical Test fixture	/	/	N/A	N/A
Behlman	AC Power Source	BL+30-1-C1-1	06953	N/A	N/A
BMI	Data Logger	3030A	35558	2015-10-22	2016-10-22

Note: Current was measured by Fluke 189; forward voltage was measured by Fluke 179.

Statement of Traceability: *Bay Area Compliance Laboratories Corp. certifies that all calibrations have been performed using suitable standards traceable to the NATIONAL INSTITUTE of STANDARDS and TECHNOLOGY (NIST).*

1.10 Electrical Rating for the Photometric Measurement

Voltage	30 V (typical)
Current	1.000 Amp
Power	30 W

2 SUMMARY OF TEST RESULTS

Data Set	90°C
Number of Samples	13
Failure Observed	0
Test Duration and Test Interval	10,000 hours and 1,000 hours
Average Lumen Maintenance at 10,000 hours	94.92%
Average Chromaticity Shift at 10,000 hours	0.0013
Reported TM-21 L70 Lifetime	> 55,000 hours

Data Set	55°C
Number of Samples	13
Failure Observed	0
Test Duration and Test Interval	10,000 hours and 1,000 hours
Average Lumen Maintenance at 10,000 hours	96.25%
Average Chromaticity Shift at 10,000 hours	0.0011
Reported TM-21 L70 Lifetime	> 55,000 hours

3 SUMMARY OF TEST DATA

3.1 Photometric and Electrical Measurements at 0 Hour and 25°C

Sample Serial Number	Forward Voltage (V)	Current (A)	Power (W)	Luminous Flux (Lumens)	Efficacy (Lm/W)	CCT (K)	CRI	Chroma _x	Chroma _y	Chroma _{u'}	Chroma _{v'}
90°C LED Module											
2570925	28.89	1.000	28.89	3011	104.22	2955	86.3	0.4423	0.4096	0.2516	0.5243
2570909	28.91	1.000	28.91	3003	103.87	2980	84.3	0.4392	0.4064	0.2510	0.5226
2570926	28.80	1.000	28.80	2976	103.33	2957	83.7	0.4417	0.4086	0.2517	0.5239
2570927	29.12	1.000	29.12	2981	102.37	2968	83.7	0.4404	0.4073	0.2514	0.5232
2570910	28.85	1.000	28.85	2980	103.29	2961	83.7	0.4415	0.4087	0.2515	0.5239
2570902	28.88	1.000	28.88	2997	103.77	2952	83.7	0.4420	0.4087	0.2518	0.5239
2570911	29.12	1.000	29.12	3014	103.50	2973	83.6	0.4402	0.4075	0.2512	0.5232
2570930	28.79	1.000	28.79	3013	104.65	2971	83.7	0.4398	0.4065	0.2514	0.5228
2570904	28.80	1.000	28.80	3004	104.30	2962	83.7	0.4407	0.4073	0.2516	0.5232
2570923	29.01	1.000	29.01	3011	103.79	2973	83.6	0.4398	0.4068	0.2512	0.5229
2570914	28.91	1.000	28.91	3001	103.80	2954	83.7	0.4419	0.4086	0.2518	0.5239
2570924	28.85	1.000	28.85	2980	103.29	2953	83.6	0.4421	0.4089	0.2518	0.5240
2570915	29.21	1.000	29.21	3014	103.18	2961	83.6	0.4412	0.4081	0.2516	0.5236
Average	28.93	1.000	28.93	2998.8	103.64	2963	83.9	0.4410	0.4079	0.2515	0.5235
Minimum	28.79	1.000	28.79	2976	102.37	2952	83.6	0.4392	0.4064	0.2510	0.5226
Maximum	29.21	1.000	29.21	3014	104.65	2980	86.3	0.4423	0.4096	0.2518	0.5243
Median	28.89	1.000	28.89	3003	103.77	2961	83.7	0.4412	0.4081	0.2516	0.5236
S.T. Deviation	0.14	0.000	0.14	14.6	0.58	9.1	0.74	0.0010	0.0010	0.0003	0.0005

Sample Serial Number	Forward Voltage (V)	Current (A)	Power (W)	Luminous Flux (Lumens)	Efficacy (Lm/W)	CCT (K)	CRI	Chroma _x	Chroma _y	Chroma _{u'}	Chroma _{v'}
55°C LED Module											
2570928	29.02	1.000	29.02	2989	103.00	2959	84.0	0.4406	0.4067	0.2518	0.5230
2570913	29.00	1.000	29.00	2998	103.37	2965	83.8	0.4399	0.4060	0.2517	0.5226
2570906	28.98	1.000	28.98	3036	104.76	2964	83.5	0.4412	0.4084	0.2515	0.5237
2570929	28.98	1.000	28.98	2907	100.31	2968	84.0	0.4406	0.4077	0.2514	0.5233
2570912	28.85	1.000	28.85	3008	104.26	2955	83.7	0.4418	0.4087	0.2517	0.5239
2570907	28.85	1.000	28.85	3035	105.20	2961	83.6	0.4415	0.4087	0.2515	0.5239
2570905	28.98	1.000	28.98	2958	102.07	2966	83.8	0.4407	0.4076	0.2515	0.5233
2570918	28.99	1.000	28.99	3029	104.48	2958	83.7	0.4417	0.4087	0.2516	0.5239
2570916	28.98	1.000	28.98	3006	103.73	2987	84.2	0.4387	0.4063	0.2508	0.5225
2570922	28.86	1.000	28.86	2981	103.29	2961	83.7	0.4416	0.4089	0.2515	0.5240
2570917	29.05	1.000	29.05	3016	103.82	2975	83.5	0.4401	0.4077	0.2510	0.5233
2570920	28.90	1.000	28.90	3037	105.09	2959	83.8	0.4405	0.4064	0.2519	0.5228
2570919	28.90	1.000	28.90	3037	105.09	2973	83.7	0.4393	0.4058	0.2514	0.5224
Average	28.95	1.000	28.95	3002.8	103.73	2965	83.9	0.4406	0.4075	0.2515	0.5233
Minimum	28.85	1.000	28.85	2907	100.31	2952	83.6	0.4387	0.4058	0.2508	0.5224
Maximum	29.05	1.000	29.05	3037	105.20	2980	86.3	0.4418	0.4089	0.2519	0.5240
Median	28.98	1.000	28.98	3008	103.82	2962	83.7	0.4406	0.4077	0.2515	0.5233
S.T. Deviation	0.07	0.000	0.07	37.9	1.39	8.7	0.76	0.0010	0.0011	0.0003	0.0006

Environmental Conditions	
Relative Humidity	44%-48%
Ambient Temperature	24°C - 25°C
Photometric Measurement Date(s)	2014-06-12

3.2 1,000 Hour Lumen Maintenance at 25°C

Sample Serial Number	Forward Voltage (V)	Current (A)	Luminous Flux (Lumens)	% Lumens	Chroma x	Chroma y	Chroma u'	Chroma v'	$\Delta u'v'$
90°C LED Module									
2570925	28.86	1.000	2919	96.94	0.4417	0.4097	0.2512	0.5243	0.0004
2570909	28.95	1.000	2968	98.83	0.4393	0.4072	0.2507	0.5230	0.0004
2570926	28.85	1.000	2956	99.33	0.4410	0.4089	0.2511	0.5239	0.0006
2570927	29.16	1.000	2946	98.83	0.4406	0.4082	0.2512	0.5235	0.0005
2570910	28.84	1.000	2951	99.03	0.4408	0.4090	0.2509	0.5239	0.0006
2570902	28.87	1.000	2981	99.47	0.4413	0.4094	0.2511	0.5241	0.0008
2570911	29.19	1.000	2955	98.04	0.4397	0.4084	0.2505	0.5235	0.0008
2570930	28.82	1.000	2952	97.98	0.4390	0.4070	0.2506	0.5228	0.0007
2570904	28.83	1.000	2941	97.90	0.4394	0.4076	0.2506	0.5231	0.0010
2570923	29.10	1.000	2969	98.61	0.4396	0.4076	0.2508	0.5232	0.0005
2570914	28.98	1.000	2970	98.97	0.4413	0.4092	0.2512	0.5240	0.0007
2570924	28.91	1.000	2973	99.77	0.4414	0.4096	0.2511	0.5242	0.0008
2570915	29.30	1.000	2967	98.44	0.4406	0.4087	0.2509	0.5237	0.0007
Average	28.97	1.000	2957.5	98.62	0.4404	0.4085	0.2509	0.5236	0.0006
Minimum	28.82	1.000	2919	96.94	0.4390	0.4070	0.2505	0.5228	0.0004
Maximum	29.30	1.000	2981	99.77	0.4417	0.4097	0.2512	0.5243	0.0010
Median	28.91	1.000	2956	98.83	0.4406	0.4087	0.2509	0.5237	0.0007
S.T. Deviation	0.16	0.000	16.5	0.76	0.0009	0.0009	0.0002	0.0005	0.0002

Sample Serial Number	Forward Voltage (V)	Current (A)	Luminous Flux (Lumens)	% Lumens	Chroma x	Chroma y	Chroma u'	Chroma v'	$\Delta u'v'$
55°C LED Module									
2570928	29.06	1.000	2981	99.73	0.4405	0.4071	0.2516	0.5231	0.0003
2570913	29.03	1.000	2997	99.97	0.4394	0.4063	0.2512	0.5226	0.0005
2570906	29.01	1.000	3048	100.40	0.4407	0.4087	0.2510	0.5238	0.0005
2570929	29.02	1.000	2879	99.04	0.4400	0.4076	0.2510	0.5232	0.0004
2570912	28.88	1.000	2996	99.60	0.4418	0.4093	0.2515	0.5241	0.0003
2570907	28.88	1.000	3033	99.93	0.4409	0.4092	0.2509	0.5240	0.0006
2570905	28.98	1.000	2952	99.80	0.4407	0.4082	0.2512	0.5236	0.0003
2570918	29.02	1.000	3037	100.26	0.4413	0.4090	0.2513	0.5240	0.0004
2570916	29.03	1.000	3002	99.87	0.4385	0.4068	0.2504	0.5227	0.0004
2570922	29.87	1.000	2979	99.93	0.4412	0.4094	0.2510	0.5241	0.0005
2570917	29.08	1.000	3022	100.20	0.4398	0.4081	0.2507	0.5234	0.0004
2570920	28.99	1.000	3056	100.63	0.4399	0.4068	0.2513	0.5229	0.0006
2570919	28.96	1.000	3047	100.33	0.4391	0.4062	0.2511	0.5225	0.0003
Average	29.06	1.000	3002	99.98	0.4403	0.4079	0.2511	0.5234	0.0004
Minimum	28.88	1.000	2879	99.04	0.4385	0.4062	0.2504	0.5225	0.0003
Maximum	29.87	1.000	3056	100.63	0.4418	0.4094	0.2516	0.5241	0.0006
Median	29.02	1.000	3002	99.93	0.4405	0.4081	0.2511	0.5234	0.0004
S.T. Deviation	0.25	0.000	48.6	0.41	0.0009	0.0012	0.0003	0.0006	0.0001

Environmental Conditions	
Relative Humidity	42%-47%
Ambient Temperature	25°C - 27°C
Photometric Measurement Date(s)	2014-08-01 to 04

3.3 2,000 Hour Lumen Maintenance at 25°C

Sample Serial Number	Forward Voltage (V)	Current (A)	Luminous Flux (Lumens)	% Lumens	Chroma x	Chroma y	Chroma u'	Chroma v'	$\Delta u'v'$
90°C LED Module									
2570925	28.87	1.000	2900	96.31	0.4412	0.4098	0.2509	0.5242	0.0008
2570909	28.98	1.000	2933	97.67	0.4390	0.4074	0.2505	0.5230	0.0007
2570926	28.84	1.000	2920	98.12	0.4407	0.4090	0.2509	0.5239	0.0008
2570927	29.16	1.000	2886	96.81	0.4404	0.4087	0.2508	0.5237	0.0008
2570910	28.90	1.000	2922	98.05	0.4408	0.4092	0.2509	0.5240	0.0007
2570902	28.90	1.000	2897	96.66	0.4415	0.4096	0.2511	0.5242	0.0008
2570911	29.21	1.000	2886	95.75	0.4395	0.4084	0.2504	0.5235	0.0009
2570930	28.83	1.000	2907	96.48	0.4387	0.4067	0.2506	0.5227	0.0008
2570904	28.82	1.000	2903	96.64	0.4392	0.4072	0.2507	0.5229	0.0010
2570923	29.06	1.000	2920	96.98	0.4393	0.4074	0.2507	0.5230	0.0006
2570914	28.97	1.000	2932	97.70	0.4410	0.4090	0.2511	0.5239	0.0007
2570924	28.93	1.000	2920	97.99	0.4412	0.4095	0.2510	0.5241	0.0008
2570915	29.30	1.000	2933	97.31	0.4402	0.4085	0.2508	0.5236	0.0008
Average	28.98	1.000	2912.2	97.11	0.4402	0.4085	0.2508	0.5236	0.0008
Minimum	28.82	1.000	2886	95.75	0.4387	0.4067	0.2504	0.5227	0.0006
Maximum	29.30	1.000	2933	98.12	0.4415	0.4098	0.2511	0.5242	0.0010
Median	28.93	1.000	2920	96.98	0.4404	0.4087	0.2508	0.5237	0.0008
S.T. Deviation	0.16	0.000	16.8	0.75	0.0010	0.0010	0.0002	0.0005	0.0001

Sample Serial Number	Forward Voltage (V)	Current (A)	Luminous Flux (Lumens)	% Lumens	Chroma x	Chroma y	Chroma u'	Chroma v'	$\Delta u'v'$
55°C LED Module									
2570928	29.05	1.000	2958	98.96	0.4402	0.4072	0.2513	0.5231	0.0005
2570913	29.04	1.000	2958	98.67	0.4395	0.4064	0.2512	0.5227	0.0004
2570906	29.01	1.000	3014	99.28	0.4403	0.4087	0.2507	0.5237	0.0007
2570929	29.00	1.000	2851	98.07	0.4398	0.4080	0.2507	0.5233	0.0006
2570912	28.88	1.000	2958	98.34	0.4417	0.4092	0.2514	0.5241	0.0003
2570907	28.89	1.000	2989	98.48	0.4408	0.4093	0.2508	0.5240	0.0007
2570905	28.94	1.000	2918	98.65	0.4402	0.4083	0.2509	0.5235	0.0007
2570918	29.00	1.000	3002	99.11	0.4410	0.4091	0.2510	0.5239	0.0006
2570916	29.02	1.000	2925	97.31	0.4385	0.4067	0.2504	0.5226	0.0003
2570922	28.84	1.000	2912	97.69	0.4411	0.4091	0.2511	0.5240	0.0004
2570917	29.06	1.000	2964	98.28	0.4396	0.4080	0.2506	0.5233	0.0005
2570920	28.98	1.000	3015	99.28	0.4396	0.4069	0.2511	0.5229	0.0008
2570919	28.96	1.000	2991	98.49	0.4390	0.4062	0.2510	0.5225	0.0004
Average	28.97	1.000	2958.1	98.51	0.4401	0.4079	0.2509	0.5234	0.0005
Minimum	28.84	1.000	2851	97.31	0.4385	0.4062	0.2504	0.5225	0.0003
Maximum	29.06	1.000	3015	99.28	0.4417	0.4093	0.2514	0.5241	0.0008
Median	29.00	1.000	2958	98.49	0.4402	0.4080	0.2510	0.5233	0.0005
S.T. Deviation	0.07	0.000	47.1	0.59	0.0009	0.0011	0.0003	0.0006	0.0002

Environmental Conditions	
Relative Humidity	37%-46%
Ambient Temperature	25°C-27°C
Photometric Measurement Date(s)	2014-09-16 to 17

3.4 3,000 Hour Lumen Maintenance at 25°C

Sample Serial Number	Forward Voltage (V)	Current (A)	Luminous Flux (Lumens)	% Lumens	Chroma x	Chroma y	Chroma u'	Chroma v'	$\Delta u'v'$
90°C LED Module									
2570925	28.74	1.000	2887	95.88	0.4410	0.4097	0.2508	0.5242	0.0009
2570909	28.83	1.000	2929	97.54	0.4384	0.4070	0.2503	0.5227	0.0008
2570926	28.72	1.000	2915	97.95	0.4407	0.4092	0.2508	0.5239	0.0009
2570927	29.03	1.000	2893	97.05	0.4392	0.4078	0.2504	0.5232	0.0010
2570910	28.75	1.000	2905	97.48	0.4405	0.4091	0.2507	0.5239	0.0008
2570902	28.76	1.000	2903	96.86	0.4409	0.4091	0.2510	0.5239	0.0009
2570911	29.05	1.000	2906	96.42	0.4391	0.4081	0.2502	0.5233	0.0010
2570930	28.78	1.000	2906	96.45	0.4381	0.4066	0.2502	0.5225	0.0012
2570904	28.67	1.000	2891	96.24	0.4391	0.4073	0.2506	0.5230	0.0011
2570923	28.95	1.000	2927	97.21	0.4384	0.4071	0.2502	0.5228	0.0010
2570914	28.84	1.000	2926	97.50	0.4407	0.4091	0.2508	0.5239	0.0010
2570924	28.78	1.000	2922	98.05	0.4408	0.4094	0.2508	0.5240	0.0010
2570915	29.15	1.000	2920	96.88	0.4398	0.4084	0.2506	0.5235	0.0010
Average	28.85	1.000	2910.0	97.04	0.4397	0.4083	0.2506	0.5235	0.0010
Minimum	28.67	1.000	2887	95.88	0.4381	0.4066	0.2502	0.5225	0.0008
Maximum	29.15	1.000	2929	98.05	0.4410	0.4097	0.2510	0.5242	0.0012
Median	28.78	1.000	2906	97.05	0.4398	0.4084	0.2506	0.5235	0.0010
S.T. Deviation	0.15	0.000	14.3	0.67	0.0011	0.0010	0.0003	0.0006	0.0001

Sample Serial Number	Forward Voltage (V)	Current (A)	Luminous Flux (Lumens)	% Lumens	Chroma x	Chroma y	Chroma u'	Chroma v'	$\Delta u'v'$
55°C LED Module									
2570928	28.95	1.000	2949	98.66	0.4396	0.4068	0.2511	0.5228	0.0007
2570913	28.92	1.000	2925	97.57	0.4389	0.4061	0.2510	0.5225	0.0007
2570906	28.81	1.000	3002	98.88	0.4399	0.4085	0.2506	0.5236	0.0009
2570929	28.81	1.000	2773	95.39	0.4388	0.4054	0.2512	0.5222	0.0012
2570912	28.73	1.000	2950	98.07	0.4410	0.4088	0.2512	0.5238	0.0006
2570907	28.75	1.000	2985	98.35	0.4400	0.4086	0.2506	0.5236	0.0010
2570905	28.80	1.000	2889	97.67	0.4396	0.4077	0.2507	0.5232	0.0008
2570918	28.88	1.000	2999	99.01	0.4405	0.4089	0.2508	0.5238	0.0009
2570916	28.89	1.000	2970	98.80	0.4377	0.4064	0.2501	0.5224	0.0007
2570922	28.78	1.000	2942	98.69	0.4405	0.4091	0.2507	0.5239	0.0008
2570917	28.95	1.000	2977	98.71	0.4389	0.4077	0.2503	0.5231	0.0008
2570920	28.76	1.000	2960	97.46	0.4391	0.4049	0.2516	0.5220	0.0008
2570919	28.83	1.000	2993	98.55	0.4383	0.4059	0.2507	0.5223	0.0007
Average	28.84	1.000	2947.2	98.14	0.4394	0.4073	0.2508	0.5230	0.0008
Minimum	28.73	1.000	2773	95.39	0.4377	0.4049	0.2501	0.5220	0.0006
Maximum	28.95	1.000	3002	99.01	0.4410	0.4091	0.2516	0.5239	0.0012
Median	28.81	1.000	2960	98.55	0.4396	0.4077	0.2507	0.5231	0.0008
S.T. Deviation	0.08	0.000	61.3	0.98	0.0009	0.0015	0.0004	0.0007	0.0002

Environmental Conditions	
Relative Humidity	38%-47%
Ambient Temperature	24°C-25°C
Photometric Measurement Date(s)	2014-11-12 to 13

3.5 4,000 Hour Lumen Maintenance at 25°C

Sample Serial Number	Forward Voltage (V)	Current (A)	Luminous Flux (Lumens)	% Lumens	Chroma x	Chroma y	Chroma u'	Chroma v'	$\Delta u'v'$
90°C LED Module									
2570925	28.83	1.000	2872	95.38	0.4412	0.4100	0.2508	0.5243	0.0009
2570909	28.91	1.000	2925	97.40	0.4384	0.4072	0.2502	0.5228	0.0009
2570926	28.78	1.000	2893	97.21	0.4411	0.4095	0.2509	0.5241	0.0008
2570927	29.10	1.000	2894	97.08	0.4396	0.4081	0.2506	0.5234	0.0009
2570910	28.86	1.000	2900	97.32	0.4409	0.4094	0.2508	0.5241	0.0007
2570902	28.86	1.000	2871	95.80	0.4414	0.4095	0.2511	0.5242	0.0008
2570911	29.11	1.000	2894	96.02	0.4395	0.4084	0.2504	0.5235	0.0009
2570930	28.90	1.000	2883	95.69	0.4386	0.4069	0.2504	0.5227	0.0009
2570904	28.74	1.000	2868	95.47	0.4395	0.4076	0.2507	0.5231	0.0009
2570923	29.01	1.000	2902	96.38	0.4389	0.4074	0.2504	0.5230	0.0008
2570914	28.93	1.000	2897	96.53	0.4412	0.4094	0.2510	0.5241	0.0008
2570924	28.87	1.000	2896	97.18	0.4412	0.4097	0.2509	0.5242	0.0009
2570915	29.23	1.000	2897	96.12	0.4403	0.4086	0.2508	0.5237	0.0008
Average	28.93	1.000	2891.7	96.43	0.4401	0.4086	0.2507	0.5236	0.0008
Minimum	28.74	1.000	2868	95.38	0.4384	0.4069	0.2502	0.5227	0.0007
Maximum	29.23	1.000	2925	97.40	0.4414	0.4100	0.2511	0.5243	0.0009
Median	28.90	1.000	2894	96.38	0.4403	0.4086	0.2508	0.5237	0.0009
S.T. Deviation	0.14	0.000	15.3	0.74	0.0011	0.0011	0.0003	0.0006	0.0001

Sample Serial Number	Forward Voltage (V)	Current (A)	Luminous Flux (Lumens)	% Lumens	Chroma x	Chroma y	Chroma u'	Chroma v'	$\Delta u'v'$
55°C LED Module									
2570928	29.02	1.000	2924	97.83	0.4402	0.4072	0.2513	0.5231	0.0005
2570913	28.99	1.000	2922	97.46	0.4394	0.4065	0.2511	0.5227	0.0006
2570906	28.91	1.000	2975	97.99	0.4405	0.4089	0.2508	0.5238	0.0007
2570929	28.87	1.000	2762	95.01	0.4393	0.4064	0.2511	0.5226	0.0008
2570912	28.80	1.000	2936	97.61	0.4415	0.4092	0.2513	0.5241	0.0004
2570907	28.81	1.000	2962	97.59	0.4406	0.4090	0.2508	0.5239	0.0007
2570905	28.88	1.000	2876	97.23	0.4402	0.4081	0.2509	0.5234	0.0005
2570918	28.95	1.000	2979	98.35	0.4411	0.4092	0.2510	0.5240	0.0006
2570916	28.98	1.000	2946	98.00	0.4382	0.4067	0.2503	0.5226	0.0005
2570922	28.80	1.000	2922	98.02	0.4411	0.4094	0.2510	0.5241	0.0005
2570917	29.02	1.000	2935	97.31	0.4395	0.4080	0.2505	0.5233	0.0005
2570920	28.91	1.000	2943	96.90	0.4400	0.4061	0.2517	0.5226	0.0003
2570919	28.92	1.000	2977	98.02	0.4390	0.4063	0.2509	0.5226	0.0004
Average	28.91	1.000	2927.6	97.49	0.4400	0.4078	0.2510	0.5233	0.0005
Minimum	28.80	1.000	2762	95.01	0.4382	0.4061	0.2503	0.5226	0.0003
Maximum	29.02	1.000	2979	98.35	0.4415	0.4094	0.2517	0.5241	0.0008
Median	28.91	1.000	2936	97.61	0.4402	0.4080	0.2510	0.5233	0.0005
S.T. Deviation	0.08	0.000	57.3	0.84	0.0009	0.0013	0.0004	0.0006	0.0001

Environmental Conditions	
Relative Humidity	42%
Ambient Temperature	24°C-25°C
Photometric Measurement Date(s)	2015-01-11

3.6 5,000 Hour Lumen Maintenance at 25°C

Sample Serial Number	Forward Voltage (V)	Current (A)	Luminous Flux (Lumens)	% Lumens	Chroma x	Chroma y	Chroma u'	Chroma v'	$\Delta u'v'$
90°C LED Module									
2570925	28.81	1.000	2856	94.85	0.4408	0.4097	0.2506	0.5242	0.0010
2570909	28.90	1.000	2925	97.40	0.4380	0.4069	0.2500	0.5226	0.0010
2570926	28.77	1.000	2899	97.41	0.4406	0.4091	0.2508	0.5239	0.0009
2570927	29.11	1.000	2886	96.81	0.4391	0.4078	0.2504	0.5232	0.0010
2570910	28.82	1.000	2902	97.38	0.4405	0.4092	0.2507	0.5239	0.0009
2570902	28.87	1.000	2877	96.00	0.4409	0.4092	0.2509	0.5240	0.0009
2570911	29.15	1.000	2884	95.69	0.4388	0.4080	0.2501	0.5232	0.0011
2570930	29.11	1.000	2873	95.35	0.4382	0.4067	0.2503	0.5226	0.0011
2570904	28.78	1.000	2881	95.91	0.4390	0.4074	0.2505	0.5230	0.0012
2570923	29.01	1.000	2903	96.41	0.4382	0.4070	0.2501	0.5227	0.0011
2570914	28.90	1.000	2901	96.67	0.4404	0.4089	0.2507	0.5238	0.0011
2570924	28.84	1.000	2897	97.21	0.4405	0.4093	0.2506	0.5240	0.0012
2570915	29.22	1.000	2898	96.15	0.4397	0.4084	0.2505	0.5235	0.0011
Average	28.95	1.000	2890.9	96.40	0.4396	0.4083	0.2505	0.5234	0.0011
Minimum	28.77	1.000	2856	94.85	0.4380	0.4067	0.2500	0.5226	0.0009
Maximum	29.22	1.000	2925	97.41	0.4409	0.4097	0.2509	0.5242	0.0012
Median	28.90	1.000	2897	96.41	0.4397	0.4084	0.2505	0.5235	0.0011
S.T. Deviation	0.16	0.000	17.3	0.84	0.0011	0.0010	0.0003	0.0006	0.0001

Sample Serial Number	Forward Voltage (V)	Current (A)	Luminous Flux (Lumens)	% Lumens	Chroma x	Chroma y	Chroma u'	Chroma v'	$\Delta u'v'$
55°C LED Module									
2570928	28.98	1.000	2929	97.99	0.4395	0.4068	0.2510	0.5228	0.0008
2570913	28.95	1.000	2936	97.93	0.4387	0.4061	0.2508	0.5224	0.0008
2570906	28.89	1.000	2983	98.25	0.4398	0.4085	0.2505	0.5235	0.0010
2570929	28.88	1.000	2753	94.70	0.4386	0.4061	0.2508	0.5224	0.0011
2570912	28.77	1.000	2936	97.61	0.4409	0.4089	0.2510	0.5239	0.0007
2570907	28.79	1.000	2970	97.86	0.4399	0.4085	0.2506	0.5236	0.0010
2570905	28.87	1.000	2870	97.03	0.4398	0.4077	0.2509	0.5232	0.0006
2570918	28.92	1.000	2981	98.42	0.4404	0.4089	0.2507	0.5238	0.0009
2570916	28.95	1.000	2930	97.47	0.4378	0.4065	0.2501	0.5225	0.0007
2570922	28.79	1.000	2922	98.02	0.4404	0.4090	0.2507	0.5238	0.0008
2570917	28.99	1.000	2955	97.98	0.4389	0.4078	0.2502	0.5231	0.0008
2570920	28.89	1.000	2954	97.27	0.4394	0.4061	0.2513	0.5225	0.0006
2570919	28.88	1.000	2991	98.49	0.4383	0.4060	0.2506	0.5223	0.0007
Average	28.89	1.000	2931.5	97.62	0.4394	0.4075	0.2507	0.5231	0.0008
Minimum	28.77	1.000	2753	94.70	0.4378	0.4060	0.2501	0.5223	0.0006
Maximum	28.99	1.000	2991	98.49	0.4409	0.4090	0.2513	0.5239	0.0011
Median	28.89	1.000	2936	97.93	0.4395	0.4077	0.2507	0.5231	0.0008
S.T. Deviation	0.07	0.000	62.6	0.97	0.0009	0.0012	0.0003	0.0006	0.0001

Environmental Conditions	
Relative Humidity	20%-27%
Ambient Temperature	23°C-24°C
Photometric Measurement Date(s)	2015-02-23 to 24

3.7 6,000 Hour Lumen Maintenance at 25°C

Sample Serial Number	Forward Voltage (V)	Current (A)	Luminous Flux (Lumens)	% Lumens	Chroma x	Chroma y	Chroma u'	Chroma v'	$\Delta u'v'$
90°C LED Module									
2570925	28.87	1.000	2855	94.82	0.4407	0.4099	0.2505	0.5242	0.0012
2570909	28.98	1.000	2915	97.07	0.4378	0.4069	0.2499	0.5226	0.0011
2570926	28.86	1.000	2887	97.01	0.4404	0.4092	0.2506	0.5239	0.0011
2570927	29.18	1.000	2886	96.81	0.4388	0.4078	0.2502	0.5231	0.0012
2570910	28.91	1.000	2884	96.78	0.4403	0.4092	0.2505	0.5239	0.0010
2570902	28.95	1.000	2866	95.63	0.4407	0.4093	0.2507	0.5240	0.0011
2570911	29.21	1.000	2975	98.71	0.4387	0.4080	0.2500	0.5232	0.0012
2570930	28.96	1.000	2867	95.15	0.4380	0.4067	0.2501	0.5226	0.0013
2570904	28.84	1.000	2862	95.27	0.4389	0.4075	0.2504	0.5230	0.0013
2570923	29.08	1.000	2884	95.78	0.4381	0.4071	0.2500	0.5227	0.0012
2570914	28.98	1.000	2882	96.03	0.4403	0.4090	0.2506	0.5238	0.0012
2570924	28.88	1.000	2881	96.68	0.4405	0.4094	0.2506	0.5240	0.0012
2570915	29.28	1.000	2880	95.55	0.4396	0.4085	0.2504	0.5235	0.0012
Average	29.00	1.000	2886.5	96.25	0.4394	0.4083	0.2504	0.5234	0.0012
Minimum	28.84	1.000	2855	94.82	0.4378	0.4067	0.2499	0.5226	0.0010
Maximum	29.28	1.000	2975	98.71	0.4407	0.4099	0.2507	0.5242	0.0013
Median	28.96	1.000	2882	96.03	0.4396	0.4085	0.2504	0.5235	0.0012
S.T. Deviation	0.14	0.000	30.5	1.06	0.0011	0.0011	0.0003	0.0006	0.0001

Sample Serial Number	Forward Voltage (V)	Current (A)	Luminous Flux (Lumens)	% Lumens	Chroma x	Chroma y	Chroma u'	Chroma v'	$\Delta u'v'$
55°C LED Module									
2570928	29.05	1.000	2920	97.69	0.4395	0.4069	0.2510	0.5229	0.0008
2570913	29.04	1.000	2923	97.50	0.4387	0.4064	0.2507	0.5226	0.0009
2570906	28.97	1.000	2969	97.79	0.4398	0.4087	0.2504	0.5236	0.0010
2570929	28.95	1.000	2763	95.05	0.4386	0.4070	0.2504	0.5228	0.0011
2570912	28.88	1.000	2947	97.97	0.4407	0.4089	0.2509	0.5238	0.0008
2570907	28.82	1.000	2952	97.27	0.4399	0.4087	0.2505	0.5236	0.0011
2570905	28.95	1.000	2868	96.96	0.4395	0.4079	0.2506	0.5233	0.0009
2570918	28.96	1.000	2967	97.95	0.4404	0.4090	0.2507	0.5238	0.0010
2570916	29.03	1.000	2934	97.60	0.4376	0.4066	0.2499	0.5225	0.0008
2570922	28.84	1.000	2917	97.85	0.4404	0.4091	0.2506	0.5239	0.0009
2570917	29.05	1.000	2948	97.75	0.4389	0.4079	0.2502	0.5232	0.0009
2570920	28.95	1.000	2964	97.60	0.4391	0.4064	0.2510	0.5226	0.0009
2570919	28.93	1.000	2979	98.09	0.4382	0.4060	0.2506	0.5223	0.0008
Average	28.96	1.000	2927.0	97.47	0.4393	0.4077	0.2506	0.5231	0.0009
Minimum	28.82	1.000	2763	95.05	0.4376	0.4060	0.2499	0.5223	0.0008
Maximum	29.05	1.000	2979	98.09	0.4407	0.4091	0.2510	0.5239	0.0011
Median	28.95	1.000	2947	97.69	0.4395	0.4079	0.2506	0.5232	0.0009
S.T. Deviation	0.08	0.000	57.4	0.79	0.0009	0.0011	0.0003	0.0006	0.0001

Environmental Conditions	
Relative Humidity	36%-38%
Ambient Temperature	23°C
Photometric Measurement Date(s)	2015-04-08

3.8 7,000 Hour Lumen Maintenance at 25°C

Sample Serial Number	Forward Voltage (V)	Current (A)	Luminous Flux (Lumens)	% Lumens	Chroma x	Chroma y	Chroma u'	Chroma v'	$\Delta u'v'$
90°C LED Module									
2570925	28.90	1.000	2852	94.72	0.4407	0.4097	0.2506	0.5241	0.0011
2570909	28.96	1.000	2909	96.87	0.4375	0.4066	0.2499	0.5225	0.0012
2570926	28.84	1.000	2883	96.88	0.4403	0.4089	0.2507	0.5238	0.0010
2570927	29.17	1.000	2883	96.71	0.4386	0.4076	0.2501	0.5230	0.0013
2570910	28.89	1.000	2888	96.91	0.4401	0.4090	0.2505	0.5238	0.0010
2570902	28.93	1.000	2878	96.03	0.4405	0.4090	0.2507	0.5238	0.0011
2570911	29.21	1.000	2872	95.29	0.4385	0.4078	0.2500	0.5231	0.0012
2570930	28.82	1.000	2853	94.69	0.4379	0.4065	0.2501	0.5225	0.0013
2570904	28.84	1.000	2854	95.01	0.4389	0.4073	0.2504	0.5229	0.0012
2570923	29.07	1.000	2888	95.91	0.4380	0.4070	0.2500	0.5227	0.0013
2570914	28.95	1.000	2877	95.87	0.4403	0.4088	0.2507	0.5237	0.0011
2570924	28.88	1.000	2884	96.78	0.4404	0.4093	0.2506	0.5239	0.0013
2570915	29.25	1.000	2865	95.06	0.4394	0.4083	0.2503	0.5234	0.0013
Average	28.98	1.000	2875.8	95.90	0.4393	0.4081	0.2504	0.5233	0.0012
Minimum	28.82	1.000	2852	94.69	0.4375	0.4065	0.2499	0.5225	0.0010
Maximum	29.25	1.000	2909	96.91	0.4407	0.4097	0.2507	0.5241	0.0013
Median	28.93	1.000	2878	95.91	0.4394	0.4083	0.2504	0.5234	0.0012
S.T. Deviation	0.15	0.000	16.5	0.87	0.0011	0.0011	0.0003	0.0006	0.0001

Sample Serial Number	Forward Voltage (V)	Current (A)	Luminous Flux (Lumens)	% Lumens	Chroma x	Chroma y	Chroma u'	Chroma v'	$\Delta u'v'$
55°C LED Module									
2570928	29.06	1.000	2917	97.59	0.4394	0.4068	0.2510	0.5228	0.0008
2570913	29.01	1.000	2932	97.80	0.4385	0.4063	0.2506	0.5225	0.0010
2570906	28.98	1.000	2970	97.83	0.4398	0.4086	0.2505	0.5236	0.0010
2570929	28.93	1.000	2749	94.56	0.4385	0.4066	0.2505	0.5226	0.0011
2570912	28.86	1.000	2941	97.77	0.4409	0.4089	0.2510	0.5239	0.0007
2570907	28.87	1.000	2945	97.03	0.4398	0.4087	0.2504	0.5236	0.0011
2570905	28.92	1.000	2865	96.86	0.4396	0.4078	0.2507	0.5232	0.0008
2570918	28.96	1.000	2958	97.66	0.4404	0.4089	0.2507	0.5238	0.0009
2570916	29.03	1.000	2923	97.24	0.4375	0.4064	0.2499	0.5224	0.0008
2570922	28.87	1.000	2893	97.05	0.4404	0.4092	0.2506	0.5239	0.0009
2570917	29.06	1.000	2937	97.38	0.4389	0.4079	0.2502	0.5232	0.0009
2570920	28.97	1.000	2930	96.48	0.4389	0.4054	0.2513	0.5222	0.0009
2570919	28.94	1.000	2959	97.43	0.4382	0.4060	0.2506	0.5223	0.0008
Average	28.96	1.000	2917	97.13	0.4393	0.4075	0.2506	0.5231	0.0009
Minimum	28.86	1.000	2749	94.56	0.4375	0.4054	0.2499	0.5222	0.0007
Maximum	29.06	1.000	2970	97.83	0.4409	0.4092	0.2513	0.5239	0.0011
Median	28.96	1.000	2932	97.38	0.4394	0.4078	0.2506	0.5232	0.0009
S.T. Deviation	0.07	0.000	57.7	0.87	0.0010	0.0013	0.0004	0.0006	0.0001

Environmental Conditions	
Relative Humidity	42%-45%
Ambient Temperature	25°C
Photometric Measurement Date(s)	2015-05-29 to 06-01

3.9 8,000 Hour Lumen Maintenance at 25°C

Sample Serial Number	Forward Voltage (V)	Current (A)	Luminous Flux (Lumens)	% Lumens	Chroma x	Chroma y	Chroma u'	Chroma v'	$\Delta u'v'$
90°C LED Module									
2570925	28.87	1.000	2859	94.95	0.4409	0.4100	0.2506	0.5243	0.0011
2570909	28.95	1.000	2906	96.77	0.4378	0.4069	0.2499	0.5226	0.0011
2570926	29.12	1.000	2883	96.88	0.4404	0.4092	0.2506	0.5239	0.0011
2570927	29.18	1.000	2866	96.14	0.4389	0.4079	0.2502	0.5232	0.0012
2570910	28.91	1.000	2868	96.24	0.4402	0.4093	0.2504	0.5239	0.0011
2570902	28.90	1.000	2860	95.43	0.4407	0.4093	0.2507	0.5240	0.0011
2570911	29.18	1.000	2872	95.29	0.4388	0.4082	0.2500	0.5233	0.0012
2570930	29.00	1.000	2842	94.32	0.4381	0.4068	0.2501	0.5226	0.0012
2570904	28.81	1.000	2835	94.37	0.4389	0.4076	0.2503	0.5231	0.0013
2570923	29.02	1.000	2865	95.15	0.4382	0.4071	0.2501	0.5228	0.0012
2570914	28.92	1.000	2860	95.30	0.4404	0.4091	0.2506	0.5239	0.0012
2570924	28.86	1.000	2865	96.14	0.4405	0.4094	0.2506	0.5240	0.0012
2570915	29.23	1.000	2867	95.12	0.4397	0.4086	0.2504	0.5236	0.0012
Average	29.00	1.000	2865.2	95.55	0.4395	0.4084	0.2504	0.5235	0.0012
Minimum	28.81	1.000	2835	94.32	0.4378	0.4068	0.2499	0.5226	0.0011
Maximum	29.23	1.000	2906	96.88	0.4409	0.4100	0.2507	0.5243	0.0013
Median	28.95	1.000	2865	95.30	0.4397	0.4086	0.2504	0.5236	0.0012
S.T. Deviation	0.14	0.000	17.3	0.82	0.0011	0.0011	0.0003	0.0006	0.0001

Sample Serial Number	Forward Voltage (V)	Current (A)	Luminous Flux (Lumens)	% Lumens	Chroma x	Chroma y	Chroma u'	Chroma v'	$\Delta u'v'$
55°C LED Module									
2570928	29.01	1.000	2900	97.02	0.4397	0.4071	0.2510	0.5230	0.0008
2570913	28.98	1.000	2913	97.16	0.4388	0.4065	0.2507	0.5226	0.0009
2570906	28.97	1.000	2964	97.63	0.4400	0.4089	0.2505	0.5237	0.0010
2570929	28.89	1.000	2733	94.01	0.4388	0.4069	0.2506	0.5228	0.0010
2570912	28.82	1.000	2938	97.67	0.4409	0.4091	0.2510	0.5239	0.0007
2570907	28.83	1.000	2938	96.80	0.4400	0.4089	0.2505	0.5237	0.0011
2570905	28.91	1.000	2854	96.48	0.4397	0.4081	0.2506	0.5234	0.0009
2570918	28.95	1.000	2945	97.23	0.4406	0.4092	0.2507	0.5239	0.0009
2570916	28.97	1.000	2918	97.07	0.4377	0.4067	0.2499	0.5225	0.0008
2570922	28.81	1.000	2892	97.01	0.4406	0.4094	0.2506	0.5240	0.0009
2570917	29.01	1.000	2920	96.82	0.4391	0.4081	0.2502	0.5233	0.0008
2570920	28.93	1.000	2920	96.15	0.4393	0.4065	0.2511	0.5227	0.0008
2570919	28.90	1.000	2956	97.33	0.4384	0.4063	0.2506	0.5225	0.0008
Average	28.92	1.000	2907	96.80	0.4395	0.4078	0.2506	0.5232	0.0009
Minimum	28.81	1.000	2733	94.01	0.4377	0.4063	0.2499	0.5225	0.0007
Maximum	29.01	1.000	2964	97.67	0.4409	0.4094	0.2511	0.5240	0.0011
Median	28.93	1.000	2920	97.02	0.4397	0.4081	0.2506	0.5233	0.0009
S.T. Deviation	0.07	0.000	59.8	0.94	0.0009	0.0012	0.0003	0.0006	0.0001

Environmental Conditions	
Relative Humidity	35%-45%
Ambient Temperature	26°C
Photometric Measurement Date(s)	2015-07-20 to 21

3.10 9,000 Hour Lumen Maintenance at 25°C

Sample Serial Number	Forward Voltage (V)	Current (A)	Luminous Flux (Lumens)	% Lumens	Chroma x	Chroma y	Chroma u'	Chroma v'	$\Delta u'v'$
90°C LED Module									
2570925	28.81	1.000	2838	94.25	0.4407	0.4100	0.2504	0.5243	0.0012
2570909	28.91	1.000	2893	96.34	0.4379	0.4071	0.2499	0.5227	0.0011
2570926	28.88	1.000	2855	95.93	0.4403	0.4092	0.2505	0.5239	0.0012
2570927	29.20	1.000	2861	95.97	0.4387	0.4079	0.2501	0.5231	0.0013
2570910	28.85	1.000	2869	96.28	0.4402	0.4092	0.2505	0.5239	0.0010
2570902	28.88	1.000	2862	95.50	0.4408	0.4094	0.2508	0.5240	0.0011
2570911	29.24	1.000	2865	95.06	0.4386	0.4081	0.2499	0.5232	0.0013
2570930	28.78	1.000	2845	94.42	0.4381	0.4068	0.2501	0.5226	0.0012
2570904	28.78	1.000	2843	94.64	0.4390	0.4076	0.2504	0.5231	0.0012
2570923	29.19	1.000	2881	95.68	0.4380	0.4071	0.2500	0.5227	0.0013
2570914	28.90	1.000	2860	95.30	0.4404	0.4091	0.2506	0.5239	0.0012
2570924	28.98	1.000	2854	95.77	0.4408	0.4096	0.2507	0.5241	0.0011
2570915	29.21	1.000	2857	94.79	0.4397	0.4085	0.2504	0.5235	0.0011
Average	28.97	1.000	2860.2	95.38	0.4395	0.4084	0.2503	0.5235	0.0012
Minimum	28.78	1.000	2838	94.25	0.4379	0.4068	0.2499	0.5226	0.0010
Maximum	29.24	1.000	2893	96.34	0.4408	0.4100	0.2508	0.5243	0.0013
Median	28.90	1.000	2860	95.50	0.4397	0.4085	0.2504	0.5235	0.0012
S.T. Deviation	0.18	0.000	15.0	0.70	0.0011	0.0011	0.0003	0.0006	0.0001

Sample Serial Number	Forward Voltage (V)	Current (A)	Luminous Flux (Lumens)	% Lumens	Chroma x	Chroma y	Chroma u'	Chroma v'	$\Delta u'v'$
55°C LED Module									
2570928	28.98	1.000	2897	96.92	0.4395	0.4071	0.2509	0.5230	0.0009
2570913	28.95	1.000	2902	96.80	0.4389	0.4066	0.2507	0.5227	0.0009
2570906	28.94	1.000	2955	97.33	0.4401	0.4090	0.2505	0.5238	0.0010
2570929	28.85	1.000	2713	93.33	0.4388	0.4075	0.2503	0.5230	0.0011
2570912	28.83	1.000	2925	97.24	0.4408	0.4093	0.2508	0.5240	0.0009
2570907	28.81	1.000	2925	96.38	0.4401	0.4090	0.2505	0.5238	0.0010
2570905	28.88	1.000	2839	95.98	0.4398	0.4081	0.2507	0.5234	0.0008
2570918	28.94	1.000	2954	97.52	0.4406	0.4093	0.2507	0.5240	0.0010
2570916	28.93	1.000	2913	96.91	0.4377	0.4067	0.2499	0.5225	0.0008
2570922	28.80	1.000	2891	96.98	0.4406	0.4093	0.2507	0.5240	0.0008
2570917	29.01	1.000	2918	96.75	0.4390	0.4082	0.2501	0.5233	0.0009
2570920	28.93	1.000	2930	96.48	0.4390	0.4064	0.2509	0.5226	0.0010
2570919	28.90	1.000	2957	97.37	0.4384	0.4063	0.2506	0.5225	0.0008
Average	28.90	1.000	2901	96.61	0.4395	0.4079	0.2506	0.5233	0.0009
Minimum	28.80	1.000	2713	93.33	0.4377	0.4063	0.2499	0.5225	0.0008
Maximum	29.01	1.000	2957	97.52	0.4408	0.4093	0.2509	0.5240	0.0011
Median	28.93	1.000	2918	96.91	0.4395	0.4081	0.2507	0.5233	0.0009
S.T. Deviation	0.07	0.000	64.9	1.08	0.0009	0.0012	0.0003	0.0006	0.0001

Environmental Conditions	
Relative Humidity	37%-45%
Ambient Temperature	26°C
Photometric Measurement Date(s)	2015-09-10 to 11

3.11 10,000 Hour Lumen Maintenance at 25°C

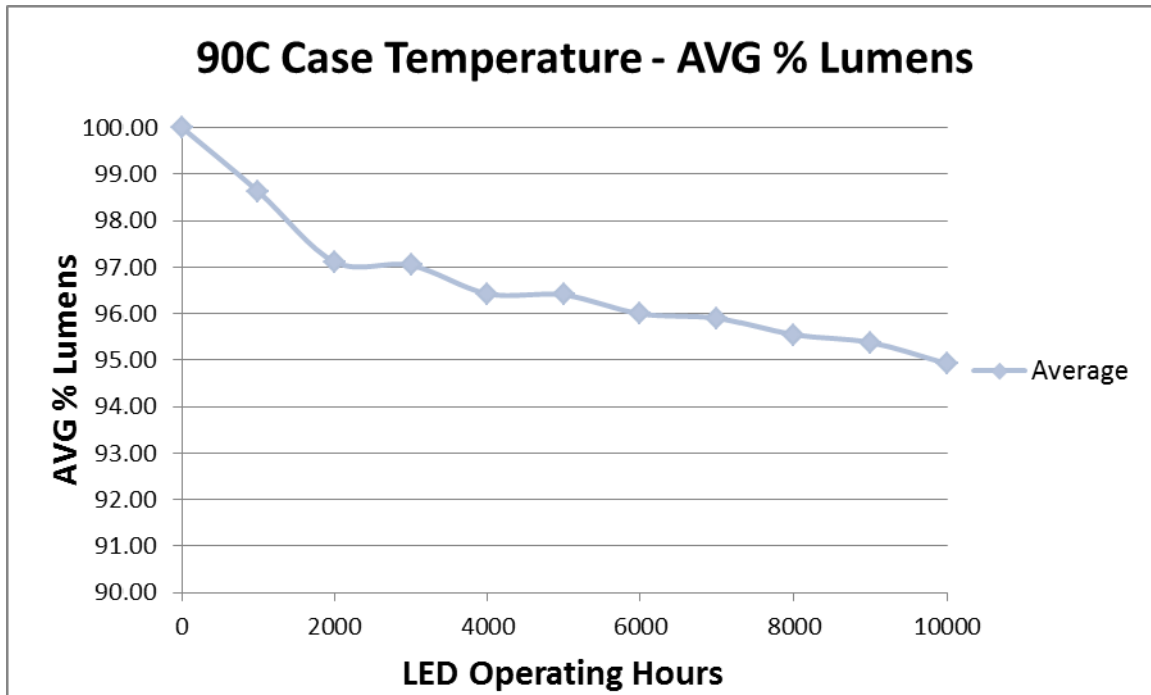
Sample Serial Number	Forward Voltage (V)	Current (A)	Luminous Flux (Lumens)	% Lumens	Chroma x	Chroma y	Chroma u'	Chroma v'	$\Delta u'v'$
90°C LED Module									
2570925	29.05	1.000	2815	93.49	0.4411	0.4103	0.2506	0.5244	0.0011
2570909	29.10	1.000	2877	95.80	0.4381	0.4075	0.2499	0.5229	0.0012
2570926	29.17	1.000	2851	95.80	0.4400	0.4092	0.2503	0.5238	0.0013
2570927	29.23	1.000	2854	95.74	0.4385	0.4080	0.2499	0.5232	0.0015
2570910	29.02	1.000	2852	95.70	0.4401	0.4095	0.2503	0.5240	0.0012
2570902	29.05	1.000	2837	94.66	0.4405	0.4094	0.2506	0.5240	0.0013
2570911	29.50	1.000	2859	94.86	0.4385	0.4083	0.2498	0.5233	0.0014
2570930	29.03	1.000	2825	93.76	0.4379	0.4069	0.2500	0.5226	0.0014
2570904	28.94	1.000	2824	94.01	0.4387	0.4076	0.2502	0.5230	0.0014
2570923	29.17	1.000	2860	94.99	0.4379	0.4072	0.2499	0.5228	0.0014
2570914	29.05	1.000	2851	95.00	0.4402	0.4092	0.2505	0.5239	0.0013
2570924	29.03	1.000	2858	95.91	0.4402	0.4097	0.2503	0.5241	0.0016
2570915	29.30	1.000	2842	94.29	0.4397	0.4089	0.2503	0.5237	0.0013
Average	29.13	1.000	2846.5	94.92	0.4393	0.4086	0.2502	0.5235	0.0013
Minimum	28.94	1.000	2815	93.49	0.4379	0.4069	0.2498	0.5226	0.0011
Maximum	29.50	1.000	2877	95.91	0.4411	0.4103	0.2506	0.5244	0.0016
Median	29.05	1.000	2851	94.99	0.4397	0.4089	0.2503	0.5237	0.0013
S.T. Deviation	0.15	0.000	17.3	0.84	0.0011	0.0011	0.0003	0.0006	0.0001

Sample Serial Number	Forward Voltage (V)	Current (A)	Luminous Flux (Lumens)	% Lumens	Chroma x	Chroma y	Chroma u'	Chroma v'	$\Delta u'v'$
55°C LED Module									
2570928	29.09	1.000	2891	96.72	0.4394	0.4072	0.2508	0.5230	0.0010
2570913	29.05	1.000	2905	96.90	0.4387	0.4067	0.2506	0.5227	0.0011
2570906	29.04	1.000	2942	96.90	0.4399	0.4091	0.2503	0.5238	0.0011
2570929	29.07	1.000	2705	93.05	0.4390	0.4079	0.2503	0.5232	0.0011
2570912	29.12	1.000	2910	96.74	0.4404	0.4090	0.2507	0.5238	0.0010
2570907	28.96	1.000	2921	96.24	0.4397	0.4090	0.2502	0.5237	0.0013
2570905	29.00	1.000	2831	95.71	0.4395	0.4082	0.2504	0.5234	0.0010
2570918	29.02	1.000	2934	96.86	0.4404	0.4093	0.2506	0.5239	0.0011
2570916	29.04	1.000	2902	96.54	0.4372	0.4065	0.2497	0.5224	0.0011
2570922	28.88	1.000	2883	96.71	0.4405	0.4095	0.2505	0.5240	0.0010
2570917	29.13	1.000	2902	96.22	0.4388	0.4082	0.2500	0.5233	0.0010
2570920	28.97	1.000	2915	95.98	0.4390	0.4061	0.2510	0.5225	0.0009
2570919	29.00	1.000	2935	96.64	0.4382	0.4063	0.2504	0.5224	0.0009
Average	29.03	1.000	2890	96.25	0.4393	0.4079	0.2504	0.5232	0.0011
Minimum	28.88	1.000	2705	93.05	0.4372	0.4061	0.2497	0.5224	0.0009
Maximum	29.13	1.000	2942	96.90	0.4405	0.4095	0.2510	0.5240	0.0013
Median	29.04	1.000	2905	96.64	0.4394	0.4082	0.2504	0.5233	0.0010
S.T. Deviation	0.07	0.000	62.5	1.03	0.0010	0.0012	0.0003	0.0006	0.0001

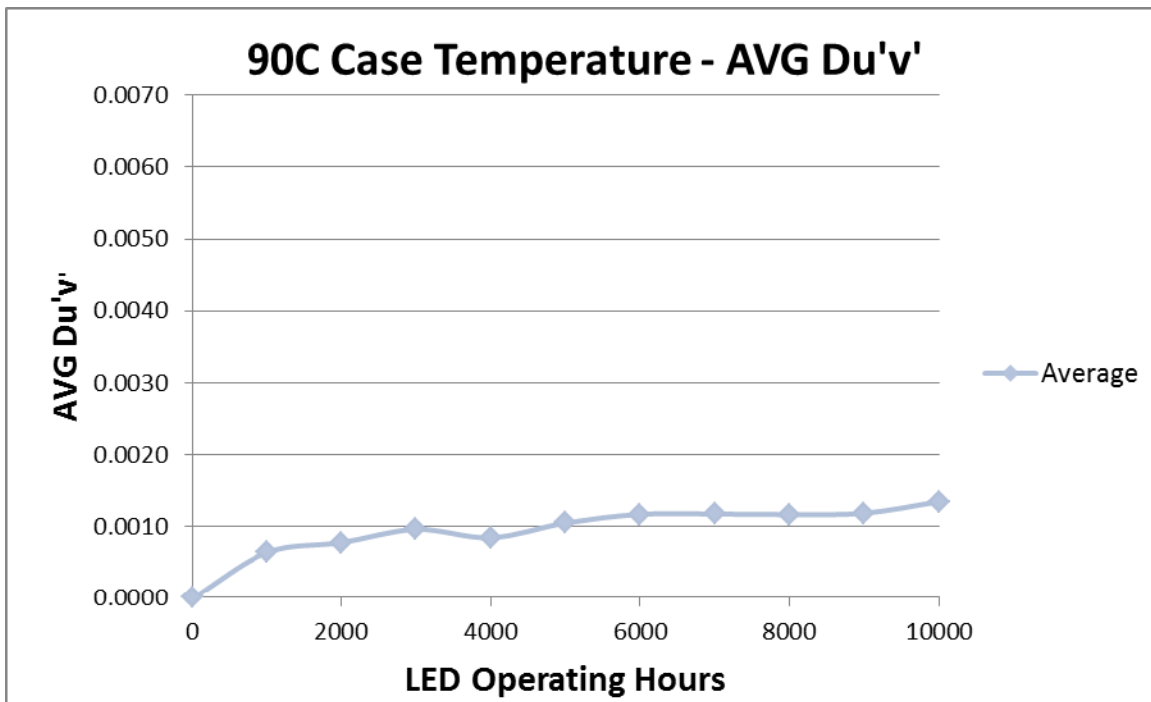
Environmental Conditions	
Relative Humidity	45%-47%
Ambient Temperature	23°C-24°C
Photometric Measurement Date(s)	2016-01-11 to 12

4 Lumen Maintenance and Chromaticity Shift

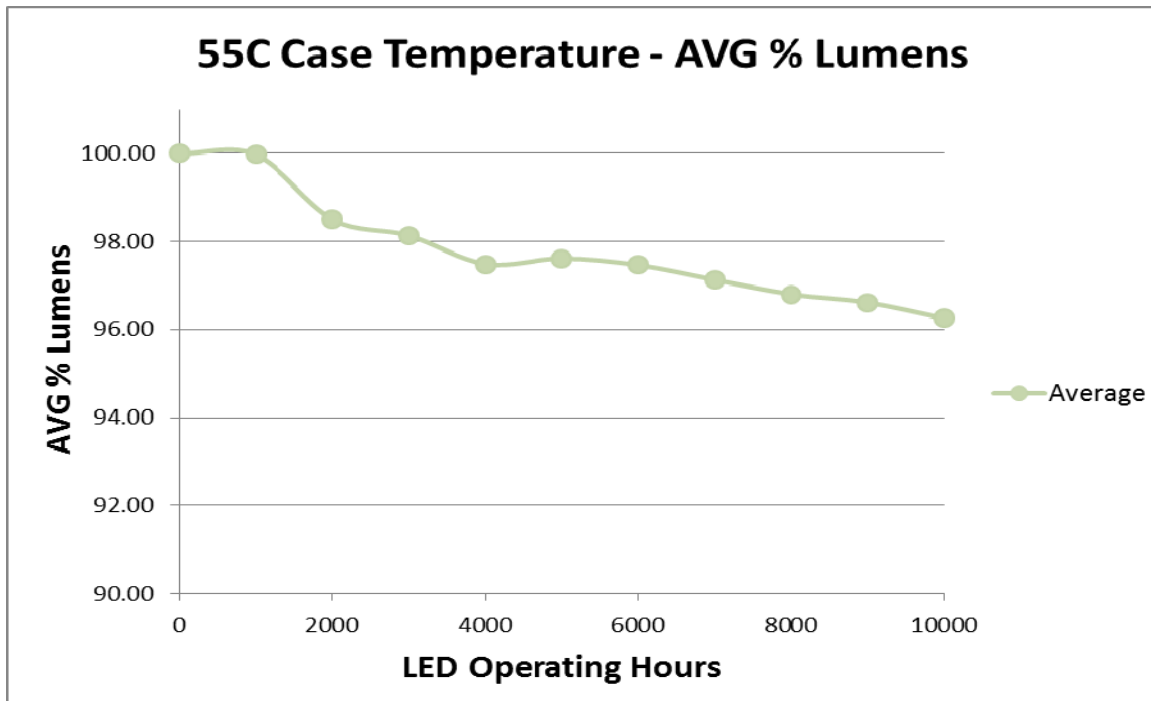
4.1 90°C Percentage Lumen Maintenance



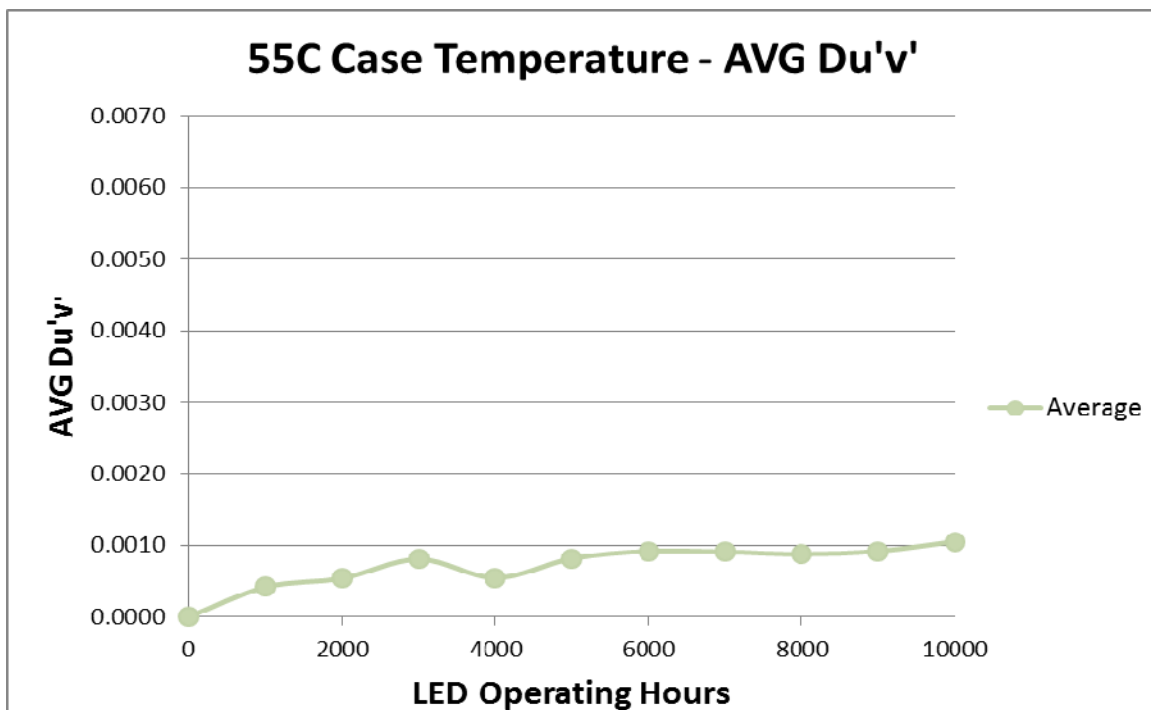
4.2 90°C Chromaticity Shift



4.3 55°C Percentage Lumen Maintenance



4.4 55°C Chromaticity Shift



5 TM-21 Lumen Maintenance Projection



TM-21 Inputs

LM-80 Test Inputs

Description of LED Light Source Tested (manufacturer, model, catalog number)

Manufacture: XICATO; Model: XCA19803030CCA

LM-80 Testing Details

Total number of units tested per case temperature:	13
Number of failures:	0
Number of units measured:	13
Test duration (hours):	10000
Tested drive current (mA):	1050
Tested case temperature 1 (T_{c} °C):	90
Tested case temperature 2 (T_{c} °C):	55
Tested case temperature 3 (T_{c} °C):	

In-Situ Inputs

Drive current for each LED package/array/module (mA):	1000
<i>In-situ</i> case temperature (T_{c} °C):	25
Percentage of initial lumens to project to (e.g. for L_{70} , enter 70):	70

Results

Time (t) at which to estimate lumen maintenance (hours):	116,400
Lumen maintenance at time (t) (%):	70.00%
Reported L70 (hours):	>55000

Test Data for 90°C Case Temperature		Test Data for 55°C Case Temperature		Tested Case Temperature 3	
Time (hours)	Lumen Maintenance (%)	Time (hours)	Lumen Maintenance (%)	Time (hours)	Lumen Maintenance (%)
0	100.00%	0	100.00%		
1000	98.62%	1000	99.98%		
2000	97.11%	2000	98.51%		
3000	97.04%	3000	98.14%		
4000	96.43%	4000	97.49%		
5000	96.40%	5000	97.62%		
6000	96.00%	6000	97.47%		
7000	95.90%	7000	97.13%		
8000	95.55%	8000	96.80%		
9000	95.38%	9000	96.61%		
10000	94.92%	10000	96.25%		

2

Calculations:

Minimum Case Temperature ($T_{s,1}$) for Extrapolation (K):	363.15
α_1	0.0000
B_1	0.9777
Maximum Case Temperature ($T_{s,2}$) for Extrapolation (K):	N/A
α_2	N/A
B_2	N/A
E_a/k_b	
k_b (eV/K)	8.6173E-05
E_a (eV)	
A	
B_0	0.9777
In Situ Case Temperature ($T_{s,i}$) (K):	298.15
α_i	0.0000
Calculated L70 (hrs):	116000
Reported L70 (hrs):	>55000

Table 1: Report at each LM-80 Test Condition

Case Temperature 1		Case Temperature 2		Case Temperature 3	
Temperature (°C):	90	Temperature (°C):	55	Temperature (°C):	
Temperature (°K):	363.15	Temperature (°K):	328.15	Temperature (°K):	
α :	2.87E-06	α :	2.88E-06	α :	
B:	0.98	B:	0.99	B:	
Calculated L70 (hrs):	116000	Calculated L70 (hrs):	121000	Calculated L70 (hrs):	
Reported L70 (hrs):	>55000	Reported L70 (hrs):	>55000	Reported L70 (hrs):	

Table 2: Report for Interpolation (based on in-situ temperature)

$T_{s,1}$ (°C)	90.00
$T_{s,1}$ (K)	363.15
α_1	2.8701E-06
B_1	0.9777
$T_{s,2}$ (°C)	
$T_{s,2}$ (K)	N/A
α_2	N/A
B_2	N/A
E_a/k_b	
A	
B_0	0.9777
$T_{s,i}$ (°C)	25
$T_{s,i}$ (K)	298.15
α_i	2.8701E-06



TM-21 Report

Table 1: Report at each LM-80 Test Condition

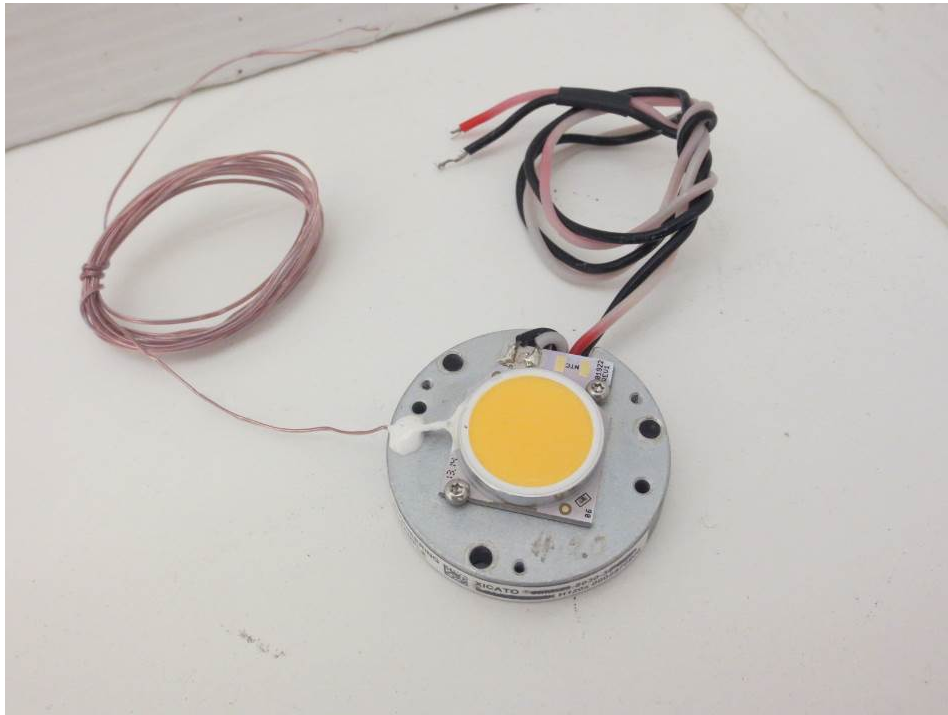
Description of LED Light Source Tested (manufacturer, model, catalog number)		Manufacture: XICATO; Model: XCA19803030CCA			
Test Condition 1 - 90°C Case Temp		Test Condition 2 - 55°C Case Temp			
Sample size	13	Sample size	13	Sample size	-
Number of failures	0	Number of failures	0	Number of failures	-
DUT drive current used in the test (mA)	1050	DUT drive current used in the test (mA)	1050	DUT drive current used in the test (mA)	-
Test duration (hours)	10,000	Test duration (hours)	10,000	Test duration (hours)	-
Test duration used for projection (hour to hour)	5,000 - 10,000	Test duration used for projection (hour to hour)	5,000 - 10,000	Test duration used for projection (hour to hour)	-
Tested case temperature (°C)	90	Tested case temperature (°C)	55	Tested case temperature (°C)	-
α	2.870E-06	α	2.876E-06	α	-
B	0.978	B	0.991	B	-
Reported L70(10k) (hours)	>55000	Reported L70(10k) (hours)	>55000	Reported L70(10k) (hours)	-

Table 2: Interpolation Report
(projection based on *in-situ* temperature entered)

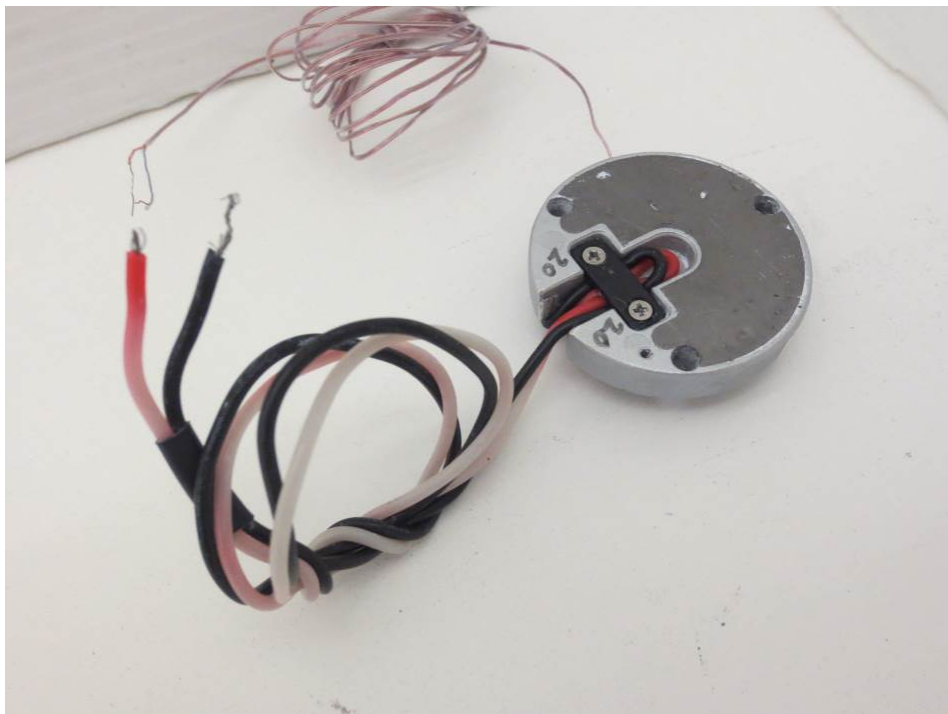
$T_{s,1}$ (°C)	90.00
$T_{s,1}$ (K)	363.15
α_1	2.870E-06
B_1	0.978
$T_{s,2}$ (°C)	-
$T_{s,2}$ (K)	-
α_2	-
B_2	-
E_g/k_b	-
A	-
B_0	0.978
$T_{s,i}$ (°C)	25.00
$T_{s,i}$ (K)	298.15
α_i	2.870E-06
Reported L70(10k) at 25°C	>55000

6 Photographs

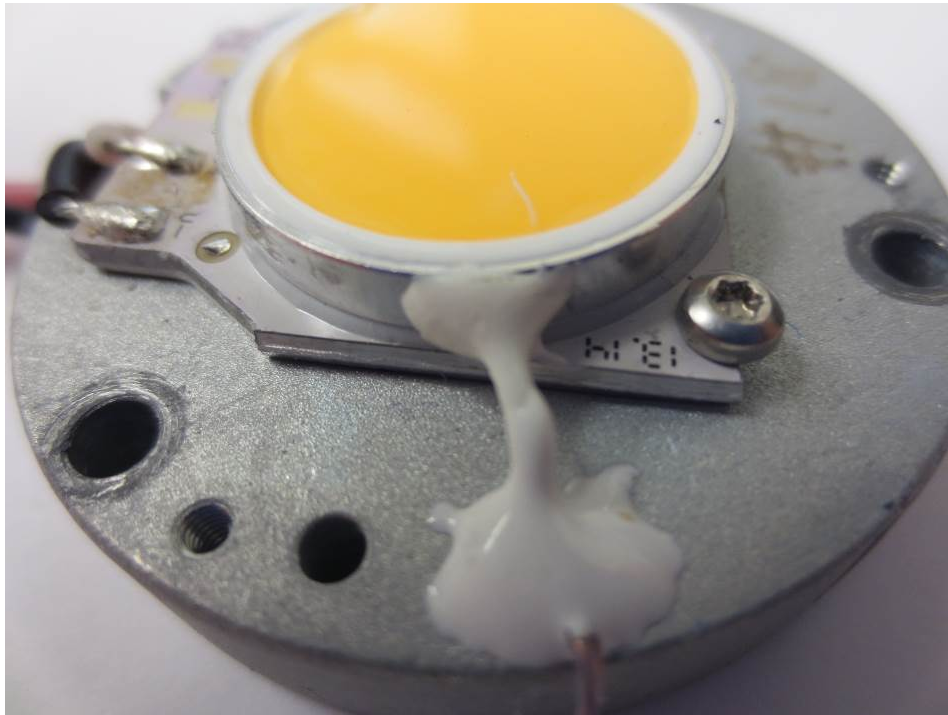
6.1 EUT – Top and Side View



6.2 EUT – Bottom and Side View



6.3 EUT – Temperature Measurement Point



- End of Report -