



Great One Global Certification Co., Ltd.

9F-2, No. 120, Qiaohe Rd., Zhonghe Dist., New Taipei City 235, Taiwan (R.O.C.)

Website : www.go-safety.com.tw TEL : +886-2-2248-0810

Email : sales@go-safety.com.tw FAX : +886-2-2248-0811

Lumen Maintenance of LED Modules Test Report



This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to the joint ISO-ILAC-IAF Communiqué dated January 2009).

Standard used :	IESNA LM-80-15 Approved Method for Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules
Date of test :	April 21, 2017 to May 30, 2018
Date of issue :	December 18, 2018
Report number :	GO18071702-101

Reviewed by :

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*Joint IAF-ILAC-ISO Communiqué
on the
Management Systems Requirements of ISO/IEC 17025:2005,
General requirements for the competence of testing and calibration
laboratories*

A laboratory's fulfilment of the requirements of ISO/IEC 17025:2005 means the laboratory meets both the technical competence requirements and **management system requirements** that are necessary for it to consistently deliver technically valid test results and calibrations. The **management system requirements** in ISO/IEC 17025:2005 (Section 4) are written in language relevant to laboratory operations and meet the principles of ISO 9001:2008 **Quality Management Systems — Requirements** and are aligned with its pertinent requirements.

IAF Chair

ILAC Chair

ISO Secretary General

January 2009



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www.ilac.org



International Laboratory Accreditation Cooperation

Joint ISO-ILAC-IAF Communiqué

8 January 2009

ILAC members will be aware that many of their accredited laboratories have been experiencing difficulty convincing their customers they should be asking laboratories to be accredited to ISO/IEC 17025, (prior to 1999 ISO Guide 25) rather than be certified (registered) to ISO 9001. The situation became more acute with the publication of ISO 9001:2008, as some customers continually asked laboratories to be certified, when they really meant accredited. The confusion is caused by the perception that accredited laboratories do not operate a recognised quality management system.

To address this problem the ILAC Laboratory Committee asked that a statement be put on accreditation (attestation) certificates, issued by their accreditation body, stating that an accredited laboratory's management system meets the principles of ISO 9001:2008. The same statement could also be used by accredited laboratories on their calibration certificates and test reports.

Working through the ISO-ILAC-IAF Joint Working Group (JWG), ILAC is pleased to be able to advise its member accreditation bodies that the problem raised by the Laboratory Committee may now be addressed as follows:-

On accreditation (attestation) certificates, accreditation bodies may add the following:

"This laboratory is accredited in accordance with the recognised International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer joint ISO-ILAC-IAF Communiqué dated January 2009)"

Accreditation Bodies choosing to use the above statement on their accreditation certificates should either supply, or provide access to (via a website), the Joint ISO-ILAC-IAF Communiqué as part of the package. (It may be convenient for accreditation bodies to do this when they issue new accreditation certificates for ISO/IEC 17025:2005 to their accredited laboratories.)

Accredited laboratories choosing to use the above statement on their test reports and calibration certificates should also either supply, or provide access to (via a website), the Joint ISO-ILAC-IAF Communiqué as part of the package for their laboratory customers.

The Joint Communiqué is available on the ILAC website at www.ilac.org on the publications and resources page.

The ILAC Laboratory Committee thanks the members of the ILAC and IAF Executive Committees and the ISO-ILAC-IAF JWG, for developing a solution to a critical market issue facing some accredited laboratories.

Daniel Pierre, ILAC Chair

Secretariat: PO Box 7507, Silverwater, NSW 2128, Australia
7 Leeds Street, Rhodes, NSW 2138, Australia
ph: + 61 2 9736 8374 fax: + 61 2 9736 8373 email: ilac@nata.asn.au



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Lumen Maintenance of LED Modules TEST REPORT

Report number: GO18071702-101

Date of issue: December 18, 2018

Tested by.....: Johnson Wang

Reported by: Stacey Jiang

Approved by.....: David Yuan

Testing laboratory.....: Great One Global Certification Co., Ltd.

Address: 9F-2, No. 120, Qiaohe Rd., Zhonghe Dist., New Taipei City
235, Taiwan (R.O.C.)

Applicant's name: Bridgelux Inc.

Address: 46430 Fremont Boulevard, Fremont, CA 94538 USA

Manufacturer's name.....: Bridgelux Inc.

Address: 46430 Fremont Boulevard, Fremont, CA 94538 USA

Standard used.....: IESNA LM-80-15 Approved Method for Measuring Luminous
Flux and Color Maintenance of LED Packages, Arrays and
Modules

Brand name.....: 

Test item description:

Product Name.....: COB

Model/Type reference: BXKE/BXKC/BXKH/BXRH-(A)(B)(C)(D)-(E)-(F)(G)(H)

Classification: COB Modules

Ratings: 41 Vdc, 1400 mA, 57.4 W



Summary of testing:

Tests performed

The test samples were configured for continuous emission and powered by 1400 mA constant current.

The LED input power was measured under normal conditions noted in details of measurement procedure and measurement results.

Measurement results: See Appendix A.

Testing location:

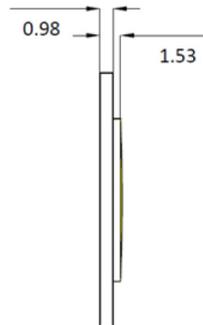
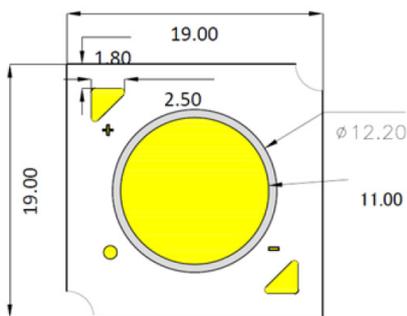
Great One Global Certification Co., Ltd.

Address:

9F-2, No.120, Qiaoh Rd., Zhonghe Dist., New Taipei City 235, Taiwan (R.O.C.)

Testing	:
Date of receipt of test item.....	: April 19, 2017
Date(s) of performance of tests	: April 21, 2017 to May 30, 2018
Number of LED Modules tested	: 12 pcs per case temperature
Test duration.....	: 9,000 hrs
Operating cycle.....	: Constant direct current
Air flow	: < 0.1 m/s
Relative humidity	: < 45%
Photometric measurement uncertainty	
Flux measurement.....	: 2.2 % (k=2)
CCT measurement	: 0.48 % (k=2)

General product information:





Description of model series:

Tests conducted on Model: BXKH-30E6500-H-003 were considered representative of the following series,

BXKE/BXKC/BXKH/BXRH-(A)(B)(C)(D)-(E)-(F)(G)(H)

A: CCT: from 22-65, for 2200-6500K

B: CRI: B/C/E/F/G/H/A/S

(B for CRI>65, C for CRI>70, E for CRI>80, F for CRI>85, G for CRI>90, H for CRI>95, A for Class A, S for CRI<70)

C: Flux indicator from 010-650, for 100 to 6500 lumens;

D: Customer Special Order Code, from 0~Z

E: Array configuration, from A-ZZ. A for 12×1, B for 12×2, etc.

F: Generation code, from 0-Z

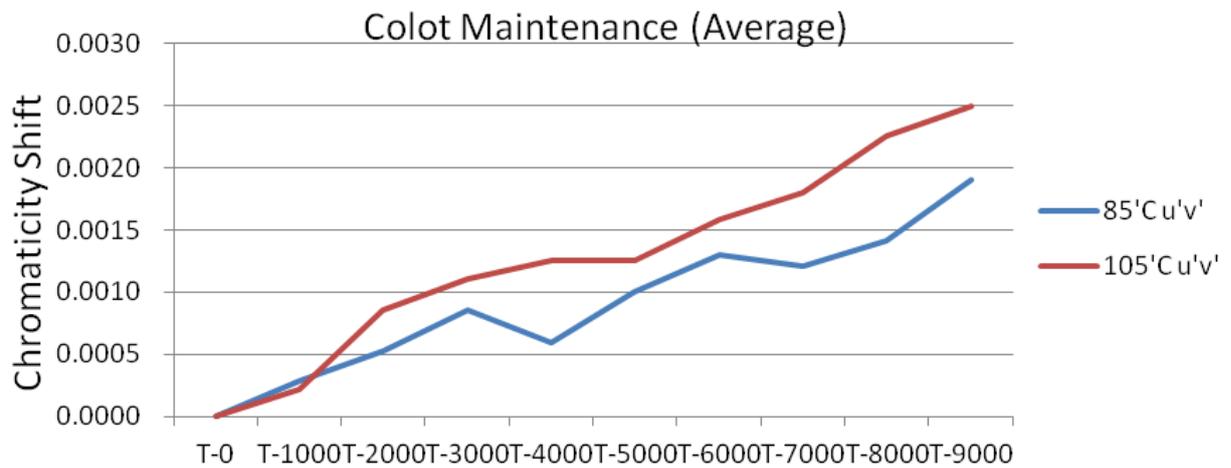
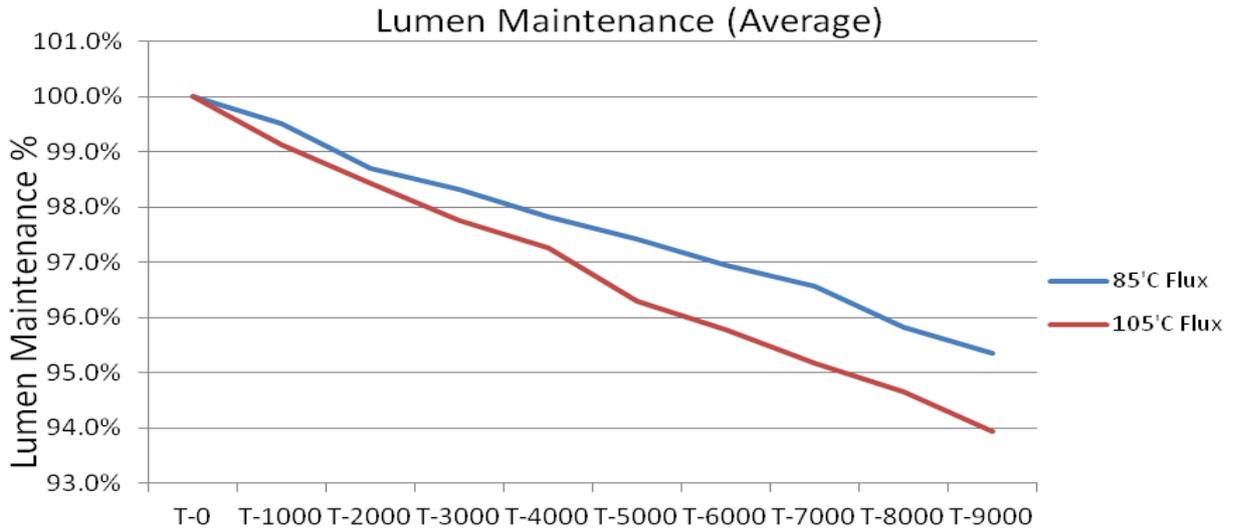
G: Customer Code, BLANK or from 0-Z

H: CCT Bin Options, 1-7 (SDCM)



Summary of results

Data Set	Case Temperature [Ts] °C	Ambient Temperature [TA] °C	Drive Current [If] mA	Lumen Maintenance at 9000 hrs	Chromaticity Shift ($\Delta u'v'$) at 9000 hrs	TM-21 Projection L70 (9000 hrs)
1	85	>80	1400	95.4%	0.0019	>50,000
2	105	>100	1400	93.9 %	0.0025	>50,000



Observation of LED Modules failures, including the failure conditions and time of failure:
No failure observed

~ End of Report ~



Appendix A

LM-80-15

Approved Method for Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules

Report No. :	GO1807170201	Test Initiation Date :	2017-04-21
Model No. :	BXKH-30E6500-H-003	Test Completion Date :	2018-05-30
Tested By :	Johnson Wang		
Manufacturer's Name:	Bridgelux Inc.		
Rated Voltage :	41 V	Temperature Selected by manufacturer:	105 °C
Rated Current :	1400 mA	Number of LED Modules tested:	12
Rated CCT	3000 K		

EQUIPMENT USED:

Inst. ID No.	Instrument Type	Function /Range	Pre Cal. Date	Cal. Date	Due Date
L401	LED current source 1(16 channel)	0~48 V dc, 0~5 A	2017/03/27	2018/03/26	-
L402	LED current source 2(8 channel)	0~48 V dc, 0~5 A	2017/03/27	2018/03/26	-
L430	LED current source 3(8 channel)	0~48 V dc, 0~5 A	2017/02/21	2018/02/20	2019/02/19
L431	LED current source 4(8 channel)	0~48 V dc, 0~5 A	2017/02/21	2018/02/20	2019/02/19
L403	Thermal Plate Controller	0°C to 95°C	-	-	-
L404	Environment Oven	-	2017/03/27	2018/03/26	2019/03/25
L405	PC Controller	-	-	-	-
L406 to L411	Temperature Data Recorder	0°C to 300°C	2017/02/21	2018/02/20	2019/02/19
L419 to L420	Auxiliary Thermal Plate Controller 1 to 2	0°C to 95°C	-	-	-
L238	Thermal Plate Cooler	0°C to 95°C	-	-	-
L240	Integrating Sphere	0.5 M	-	-	-
L244	Standard Lamp	-	2017/01/03	2017/12/29	2018/12/28
L247	Digital CC & CV DC Power Supply	0~150Vdc,0~5A	2016/12/01	2017/11/30	2018/11/29

TEST SAMPLE IDENTIFICATION

Date Received	Data Set No.	Sample No.
2017-04-21	1	17041405-1 to 17041405-12
2017-04-21	2	17041405-13 to 17041405-24



Appendix A

TEST METHOD

The samples were tested according to the IES LM-80-2015. Lumen maintenance data for each individual LED modules along with median value, standard deviation, minimum and maximum lumen maintenance value for all of the LED modules were recorded in the following table.

Temperature and Humidity

The two case temperatures, T_s , was 85 °C with a temperatures 105 °C selected by the manufacturer. The case temperature and drive current selected by the manufacturer represented their expectation for customers applications and was within their recommended operating temperature range. Case temperature was controlled to -2 °C during life testing. The temperature of the surrounding air was maintained to within -5 °C of the case temperature during testing.

Humidity was maintained to less the 65 RH throughout the life test.

Airflow was minimized (Air flow : < 0.1m/s) for proper modules starting and operation.

Photometry Measurement

For information on the photometry of the LED modules, see Reference 2.1.2, LM-79.

A Spectroradiometer and Integrating Sphere were used to measure correlated color temperature, chromaticity coordinates, and the luminous flux for each LED modules. Chromaticity coordinates, correlated color temperature and color rendering index were calculated from the spectral radiant flux measurements taken at 5 nm intervals over the range of 380 to 780 nm.

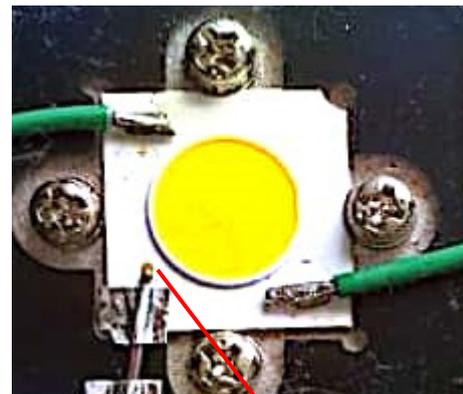
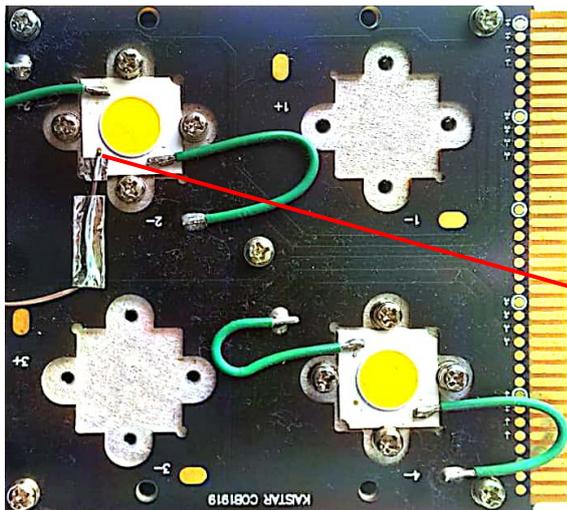
Luminous flux was measured at the drive current used during life testing.

The ambient temperature during lumen and chromaticity measurements was set to 25 °C +/- 2 °C.

Recording failures

Checking for LED modules failures either by visual observation or automatic monitoring was done at every measurement interval.

CASE TEMPERATURE, (T_s) ATTACMENT POINT, CASE SIZE





Appendix A

Data Set 1	
Case Temperature	85 °C
Measurement Current	1400 mA

Table 1-1 Initial Characteristics

Sample No.	Luminous Flux (lm)	Forward Voltage	CCT(K)	CIE-1931		CIE-1976	
17041405-1	6597.00	38.02	3063	0.4322	0.4018	0.2485	0.5198
17041405-2	6763.00	37.94	3037	0.4343	0.4031	0.2493	0.5206
17041405-3	7053.00	38.18	3024	0.4363	0.4058	0.2495	0.5220
17041405-4	7285.00	38.16	2996	0.4375	0.4046	0.2507	0.5217
17041405-5	6622.00	37.75	3040	0.4331	0.4008	0.2495	0.5195
17041405-6	7137.00	38.19	3011	0.4366	0.4047	0.2501	0.5216
17041405-7	6520.00	38.04	3029	0.4350	0.4036	0.2495	0.5209
17041405-8	6656.00	38.18	3033	0.4355	0.4051	0.2492	0.5216
17041405-9	6259.00	37.70	3055	0.4322	0.4007	0.2489	0.5193
17041405-10	6406.00	37.86	3052	0.4327	0.4015	0.2489	0.5197
17041405-11	6726.00	38.23	3028	0.4350	0.4034	0.2496	0.5208
17041405-12	6818.00	38.11	3035	0.4352	0.4049	0.2491	0.5214
Avg.	6736.8	38.03	3034	0.4346	0.4033	0.2494	0.5207
Med.	6691.0	38.08	3034	0.4350	0.4035	0.2494	0.5209
σ	300.31	0.18	18.55	0.0018	0.0018	0.0006	0.0010
Min.	6259.0	37.70	2996	0.4322	0.4007	0.2485	0.5193
Max.	7285.0	38.23	3063	0.4375	0.4058	0.2507	0.5220



Appendix A

**Table 1-2
Lumen Maintenance**

Sample No.	Lumen Maintenance% (Normalized to 100% at Initial)									
	0 h	1000 h	2000 h	3000 h	4000 h	5000 h	6000 h	7000 h	8000 h	9000 h
17041405-1	100.0%	99.7%	99.2%	98.5%	98.3%	97.9%	97.8%	97.2%	96.7%	96.0%
17041405-2	100.0%	100.0%	99.1%	98.6%	97.8%	97.5%	97.3%	97.2%	96.8%	96.4%
17041405-3	100.0%	99.8%	99.3%	99.1%	98.5%	98.1%	98.0%	97.4%	96.3%	95.4%
17041405-4	100.0%	99.1%	98.2%	97.8%	97.3%	97.0%	96.3%	95.8%	95.4%	95.2%
17041405-5	100.0%	100.0%	99.9%	99.5%	98.9%	98.2%	97.6%	97.3%	97.0%	96.3%
17041405-6	100.0%	99.4%	98.0%	97.6%	97.0%	97.0%	96.7%	96.5%	95.7%	95.2%
17041405-7	100.0%	99.4%	98.7%	98.2%	98.0%	97.4%	96.6%	96.2%	94.8%	94.6%
17041405-8	100.0%	99.2%	97.8%	97.6%	97.3%	97.0%	96.3%	96.1%	95.5%	94.9%
17041405-9	100.0%	99.6%	99.2%	98.6%	97.9%	97.2%	96.4%	96.2%	95.5%	95.8%
17041405-10	100.0%	99.5%	98.6%	97.9%	97.5%	97.5%	97.0%	96.6%	95.8%	95.2%
17041405-11	100.0%	99.2%	98.0%	98.1%	97.2%	96.7%	96.0%	95.4%	94.1%	93.8%
17041405-12	100.0%	99.1%	98.5%	98.3%	98.0%	97.6%	97.4%	96.8%	96.1%	95.3%
Avg.	100.0%	99.5%	98.7%	98.3%	97.8%	97.4%	97.0%	96.6%	95.8%	95.4%
Med.	100.0%	99.4%	98.6%	98.1%	97.7%	97.3%	96.7%	96.3%	95.6%	95.2%
σ	0.0000	0.0032	0.0064	0.0059	0.0057	0.0048	0.0065	0.0065	0.0083	0.0073
Min.	100.0%	99.1%	97.8%	97.6%	97.0%	96.7%	96.0%	95.4%	94.1%	93.8%
Max.	100.0%	100.0%	99.9%	99.5%	98.9%	98.2%	98.0%	97.4%	97.0%	96.4%

TM-21 Projection

Time	0 h	1000 h	2000 h	3000 h	4000 h	5000 h	6000 h	7000 h	8000 h	9000 h
ln (Avg.)	0.0000	-0.0050	-0.0131	-0.0169	-0.0222	-0.0261	-0.0309	-0.0350	-0.0428	-0.0476

Test duration used	9,000 hrs	Calculated L70 (9,000 hrs)	70,000 hrs
B	0.999	Report L70 (9,000 hrs)	>50,000 hrs
α	5.087E-06		



Appendix A

Table 1-3 Forward Voltage

Sample No.	Relative Forward Voltage % (Normalized to 100% at Initial)									
	0 h	1000 h	2000 h	3000 h	4000 h	5000 h	6000 h	7000 h	8000 h	9000 h
17041405-1	100.0%	100.6%	100.6%	101.3%	101.0%	101.2%	100.6%	101.7%	101.3%	100.8%
17041405-2	100.0%	101.6%	100.4%	101.5%	100.3%	100.1%	101.7%	100.8%	101.8%	100.2%
17041405-3	100.0%	100.5%	100.2%	101.7%	101.6%	100.1%	100.6%	101.1%	100.3%	101.3%
17041405-4	100.0%	101.3%	100.3%	100.9%	100.4%	100.9%	100.9%	101.8%	101.0%	101.0%
17041405-5	100.0%	100.8%	100.2%	101.8%	101.7%	101.6%	100.4%	100.5%	100.7%	101.1%
17041405-6	100.0%	100.6%	100.1%	100.0%	101.2%	101.3%	100.2%	101.0%	100.5%	101.4%
17041405-7	100.0%	100.4%	101.0%	101.2%	100.9%	100.2%	100.6%	101.5%	100.1%	100.2%
17041405-8	100.0%	101.2%	101.7%	101.0%	101.4%	101.1%	100.6%	101.0%	100.4%	100.4%
17041405-9	100.0%	100.2%	100.7%	101.2%	101.1%	100.7%	100.6%	100.4%	101.1%	101.6%
17041405-10	100.0%	101.5%	100.5%	100.3%	101.7%	101.6%	100.7%	101.0%	100.5%	100.1%
17041405-11	100.0%	100.3%	101.3%	100.5%	100.0%	100.7%	100.4%	100.1%	100.7%	100.5%
17041405-12	100.0%	101.0%	100.7%	101.4%	100.7%	100.8%	100.4%	101.5%	101.2%	101.6%
Avg.	100.0%	100.8%	100.6%	101.1%	101.0%	100.9%	100.6%	101.0%	100.8%	100.9%
Med.	100.0%	100.7%	100.6%	101.2%	101.1%	100.8%	100.6%	101.0%	100.7%	100.9%
σ	0.0000	0.0047	0.0048	0.0056	0.0058	0.0053	0.0040	0.0055	0.0049	0.0056
Min.	100.0%	100.2%	100.1%	100.0%	100.0%	100.1%	100.2%	100.1%	100.1%	100.1%
Max.	100.0%	101.6%	101.7%	101.8%	101.7%	101.6%	101.7%	101.8%	101.8%	101.6%



Appendix A

Table 1-4 Chromaticity Shift

Sample No.	Chromaticity Shift $\Delta u'v'$									
	0 h	1000 h	2000 h	3000 h	4000 h	5000 h	6000 h	7000 h	8000 h	9000 h
17041405-1	0.0000	0.0004	0.0006	0.001	0.0007	0.0012	0.0014	0.0014	0.0016	0.0023
17041405-2	0.0000	0.0001	0.0003	0.0008	0.0006	0.0012	0.0014	0.0013	0.0017	0.0022
17041405-3	0.0000	0.0002	0.0006	0.0007	0.0005	0.0012	0.0015	0.0013	0.0014	0.0020
17041405-4	0.0000	0.0003	0.0007	0.0009	0.0005	0.0009	0.0012	0.0013	0.0016	0.0020
17041405-5	0.0000	0.0004	0.0007	0.0009	0.0004	0.0008	0.001	0.0011	0.0012	0.0020
17041405-6	0.0000	0.0004	0.0005	0.0009	0.0004	0.0008	0.0011	0.0009	0.0010	0.0014
17041405-7	0.0000	0.0002	0.0004	0.0008	0.0006	0.001	0.0016	0.0015	0.0016	0.0018
17041405-8	0.0000	0.0002	0.0004	0.0007	0.0005	0.0012	0.0016	0.0013	0.0015	0.0018
17041405-9	0.0000	0.0004	0.0006	0.0005	0.0004	0.0011	0.0014	0.0012	0.0013	0.0018
17041405-10	0.0000	0.0004	0.0007	0.0008	0.0006	0.0012	0.0017	0.0016	0.0018	0.0022
17041405-11	0.0000	0.0001	0.0004	0.001	0.0009	0.0007	0.0011	0.0009	0.0013	0.0017
17041405-12	0.0000	0.0002	0.0005	0.0012	0.0008	0.0006	0.0008	0.0008	0.0009	0.0015
Avg.	0.0000	0.0003	0.0005	0.0009	0.0006	0.0010	0.0013	0.0012	0.0014	0.0019
Med.	0.0000	0.0003	0.0006	0.0009	0.0006	0.0011	0.0014	0.0013	0.0014	0.0019
σ	0.0000	0.0001	0.0001	0.0002	0.0002	0.0002	0.0003	0.0003	0.0003	0.0003
Min.	0.0000	0.0001	0.0003	0.0005	0.0004	0.0006	0.0008	0.0008	0.0009	0.0014
Max.	0.0000	0.0004	0.0007	0.0012	0.0009	0.0012	0.0017	0.0016	0.0018	0.0023



Appendix A

Data Set 2	
Case Temperature	105 °C
Measurement Current	1400 mA

Table 2-1 Initial Characteristics

Sample No.	Luminous Flux (lm)	Forward Voltage	CCT(K)	CIE-1931		CIE-1976	
17041405-13	6247.00	37.71	3051	0.4326	0.4011	0.2490	0.5196
17041405-14	6278.00	38.74	3062	0.4326	0.4025	0.2484	0.5201
17041405-15	6475.00	37.86	3063	0.4321	0.4017	0.2485	0.5197
17041405-16	6456.00	37.92	3059	0.4325	0.4020	0.2486	0.5199
17041405-17	6604.00	37.77	3055	0.4320	0.4005	0.2489	0.5192
17041405-18	6927.00	38.03	3010	0.4358	0.4030	0.2503	0.5208
17041405-19	6780.00	37.98	3044	0.4332	0.4017	0.2492	0.5199
17041405-20	5923.00	37.55	3080	0.4295	0.3981	0.2483	0.5179
17041405-21	6534.00	37.83	3056	0.4325	0.4016	0.2488	0.5197
17041405-22	6776.00	37.94	3027	0.4349	0.4032	0.2496	0.5207
17041405-23	6614.00	37.84	3038	0.4339	0.4024	0.2494	0.5203
17041405-24	6946.00	38.19	3016	0.4368	0.4058	0.2498	0.5220
Avg.	6546.7	37.95	3047	0.4332	0.4020	0.2491	0.5200
Med.	6569.0	37.89	3053	0.4326	0.4019	0.2490	0.5199
σ	299.00	0.30	20.66	0.0019	0.0018	0.0006	0.0010
Min.	5923.0	37.55	3010	0.4295	0.3981	0.2483	0.5179
Max.	6946.0	38.74	3080	0.4368	0.4058	0.2503	0.5220



Appendix A

**Table 2-2
Lumen Maintenance**

Sample No.	Lumen Maintenance% (Normalized to 100% at Initial)									
	0 h	1000 h	2000 h	3000 h	4000 h	5000 h	6000 h	7000 h	8000 h	9000 h
17041405-13	100.0%	99.1%	97.8%	97.4%	97.3%	96.6%	96.2%	95.7%	95.1%	94.4%
17041405-14	100.0%	98.9%	97.9%	97.5%	97.0%	96.0%	95.8%	94.6%	94.1%	93.3%
17041405-15	100.0%	99.3%	99.2%	98.0%	97.3%	96.0%	94.7%	93.6%	93.1%	92.4%
17041405-16	100.0%	99.3%	97.8%	96.7%	96.0%	94.8%	94.2%	93.2%	92.7%	92.0%
17041405-17	100.0%	99.1%	98.0%	97.2%	96.6%	95.4%	95.0%	94.3%	93.8%	93.1%
17041405-18	100.0%	98.7%	98.6%	97.8%	97.6%	96.7%	96.8%	96.8%	96.3%	95.7%
17041405-19	100.0%	99.1%	98.5%	98.0%	97.2%	96.4%	96.1%	96.5%	96.0%	95.3%
17041405-20	100.0%	99.3%	98.8%	97.8%	97.5%	96.6%	96.0%	95.8%	95.2%	94.4%
17041405-21	100.0%	99.1%	98.4%	98.1%	97.9%	96.9%	96.0%	94.8%	94.3%	93.6%
17041405-22	100.0%	99.3%	99.0%	98.6%	97.8%	97.1%	96.3%	95.6%	95.1%	94.4%
17041405-23	100.0%	98.9%	98.3%	98.0%	97.7%	96.7%	96.7%	95.9%	95.4%	94.7%
17041405-24	100.0%	99.5%	98.8%	98.0%	97.2%	96.4%	95.6%	95.1%	94.6%	93.9%
Avg.	100.0%	99.1%	98.4%	97.8%	97.3%	96.3%	95.8%	95.2%	94.6%	93.9%
Med.	100.0%	99.2%	98.5%	98.0%	97.4%	96.5%	96.0%	95.3%	94.8%	94.2%
σ	0.0000	0.0022	0.0048	0.0049	0.0053	0.0067	0.0079	0.0109	0.0110	0.0111
Min.	100.0%	98.7%	97.8%	96.7%	96.0%	94.8%	94.2%	93.2%	92.7%	92.0%
Max.	100.0%	99.5%	99.2%	98.6%	97.9%	97.1%	96.8%	96.8%	96.3%	95.7%

TM-21 Projection

Time	0 h	1000 h	2000 h	3000 h	4000 h	5000 h	6000 h	7000 h	8000 h	9000 h
ln (Avg.)	0.0000	-0.0088	-0.0159	-0.0227	-0.0279	-0.0377	-0.0431	-0.0496	-0.0550	-0.0627

Test duration used	9,000 hrs	Calculated L70 (9,000 hrs)	52,000 hrs
B	0.998	Report L70 (9,000 hrs)	>50,000 hrs
α	6.787E-06		



Appendix A

Table 2-3 Forward Voltage

Sample No.	Relative Forward Voltage % (Normalized to 100% at Initial)									
	0 h	1000 h	2000 h	3000 h	4000 h	5000 h	6000 h	7000 h	8000 h	9000 h
17041405-13	100.0%	101.1%	100.9%	101.8%	100.3%	100.3%	101.0%	100.7%	101.5%	101.2%
17041405-14	100.0%	100.7%	101.8%	101.1%	100.5%	100.4%	101.1%	100.6%	101.6%	101.3%
17041405-15	100.0%	101.7%	101.4%	100.8%	101.0%	100.2%	101.3%	101.3%	100.7%	101.7%
17041405-16	100.0%	101.3%	100.7%	101.4%	101.8%	101.2%	100.9%	101.1%	101.8%	101.4%
17041405-17	100.0%	101.1%	101.3%	100.3%	101.5%	100.3%	100.9%	100.4%	100.3%	101.0%
17041405-18	100.0%	101.4%	101.3%	100.5%	101.4%	101.1%	100.4%	101.1%	100.0%	100.2%
17041405-19	100.0%	100.9%	101.3%	100.2%	101.4%	100.2%	100.7%	100.8%	101.4%	100.5%
17041405-20	100.0%	101.3%	100.2%	101.8%	101.5%	100.9%	100.1%	100.6%	101.4%	100.4%
17041405-21	100.0%	100.4%	100.3%	100.4%	101.4%	101.6%	101.7%	101.8%	100.6%	101.6%
17041405-22	100.0%	100.3%	101.3%	100.1%	101.6%	100.5%	100.9%	101.5%	101.3%	101.0%
17041405-23	100.0%	101.1%	101.1%	100.4%	100.3%	101.6%	101.6%	100.3%	101.0%	100.7%
17041405-24	100.0%	101.2%	100.2%	100.6%	101.6%	101.0%	101.5%	101.3%	101.2%	100.9%
Avg.	100.0%	101.0%	101.0%	100.8%	101.2%	100.8%	101.0%	101.0%	101.1%	101.0%
Med.	100.0%	101.1%	101.2%	100.6%	101.4%	100.7%	100.9%	100.9%	101.2%	101.0%
σ	0.0000	0.0041	0.0052	0.0059	0.0054	0.0054	0.0047	0.0047	0.0055	0.0048
Min.	100.0%	100.3%	100.2%	100.1%	100.3%	100.2%	100.1%	100.3%	100.0%	100.2%
Max.	100.0%	101.7%	101.8%	101.8%	101.8%	101.6%	101.7%	101.8%	101.8%	101.7%



Appendix A

Table 2-4 Chromaticity Shift

Sample No.	Chromaticity Shift $\Delta u'v'$									
	0 h	1000 h	2000 h	3000 h	4000 h	5000 h	6000 h	7000 h	8000 h	9000 h
17041405-13	0.0000	0.0003	0.0011	0.0013	0.0012	0.0013	0.0016	0.0017	0.0021	0.0022
17041405-14	0.0000	0.0000	0.0004	0.0006	0.0009	0.0016	0.0020	0.0023	0.0026	0.0030
17041405-15	0.0000	0.0003	0.0009	0.0013	0.0009	0.0015	0.0018	0.0021	0.0025	0.0027
17041405-16	0.0000	0.0003	0.0014	0.0015	0.0009	0.0012	0.0015	0.0017	0.0021	0.0022
17041405-17	0.0000	0.0002	0.0007	0.0010	0.0009	0.0008	0.0010	0.0011	0.0019	0.0022
17041405-18	0.0000	0.0002	0.0007	0.0010	0.0015	0.0011	0.0012	0.0015	0.0021	0.0023
17041405-19	0.0000	0.0004	0.0008	0.0010	0.0013	0.0012	0.0017	0.0018	0.0022	0.0025
17041405-20	0.0000	0.0001	0.0009	0.0011	0.0016	0.0009	0.0013	0.0015	0.0017	0.0019
17041405-21	0.0000	0.0001	0.0009	0.0012	0.0015	0.0015	0.0017	0.0020	0.0025	0.0027
17041405-22	0.0000	0.0003	0.0009	0.0013	0.0015	0.0015	0.0017	0.0019	0.0023	0.0026
17041405-23	0.0000	0.0001	0.0009	0.0011	0.0014	0.0008	0.0012	0.0016	0.0020	0.0021
17041405-24	0.0000	0.0002	0.0008	0.0009	0.0013	0.0016	0.0021	0.0024	0.0030	0.0034
Avg.	0.0000	0.0002	0.0009	0.0011	0.0012	0.0013	0.0016	0.0018	0.0023	0.0025
Med.	0.0000	0.0002	0.0009	0.0011	0.0013	0.0013	0.0017	0.0018	0.0022	0.0024
σ	0.0000	0.0001	0.0002	0.0002	0.0003	0.0003	0.0003	0.0004	0.0004	0.0004
Min.	0.0000	0.0000	0.0004	0.0006	0.0009	0.0008	0.0010	0.0011	0.0017	0.0019
Max.	0.0000	0.0004	0.0014	0.0015	0.0016	0.0016	0.0021	0.0024	0.0030	0.0034



Appendix B



INTERNATIONAL
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CERTIFICATE OF ACCREDITATION

This is to attest that

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Testing Laboratory TL-531

has met the requirements of the IAS Accreditation Criteria for Testing Laboratories (AC89), has demonstrated compliance with ISO/IEC Standard 17025:2005, *General requirements for the competence of testing and calibration laboratories*, and has been accredited, commencing January 13, 2016, for the test methods listed in the approved scope of accreditation.

(see laboratory's scope of accreditation for fields of testing and accredited test methods)

This accreditation certificate supersedes any IAS accreditation bearing an earlier effective date. The certificate becomes invalid upon suspension, cancellation or revocation of accreditation. See <http://iasonline.org/More/search.html> for current accreditation information, or contact IAS at 562-364-8201.



C.P. Ramani
C.P. Ramani, P.E., C.B.O
President



Appendix B



SCOPE OF ACCREDITATION

FIELDS OF TESTING	ACCREDITED TEST METHODS
ENERGY STAR Program Requirements for Lighting (except Electromagnetic and Radio Frequency Interference, Air Tight for Restricted Air Flow, and Mercury Content) (continued)	<p>IES LM-49-2001: Approved Method of Life Testing for Incandescent Filament Lamps</p> <p>IES LM-49-2011: Approved Method of Life Testing for Incandescent Filament Lamps</p> <p>IES LM-49-12: Life Testing of Incandescent Filament Lamps</p> <p>IES LM-51-00: Approved Method for the Electrical and Photometric Measurements of High Intensity Discharge Lamps</p> <p>IES LM-54-99 /12: IESNA Guide to Lamp Seasoning</p> <p>IES LM-58-94: Guide to Spectroradiometric Measurements</p> <p>IES LM-65-01: Approved Method for Life Testing of Single-Ended Compact Fluorescent Lamps</p> <p>IES LM-65-10: Approved Method for Life Testing of Single-Ended Compact Fluorescent Lamps</p> <p>IES LM-65-14: Approved Method for Life Testing of Single-Ended Compact Fluorescent Lamps</p> <p>IES LM-66-00: Electrical and Photometric Measurements of Single-Ended Compact Fluorescent Lamps</p> <p>IES LM-66-11: Electrical and Photometric Measurements of Single-Ended Compact Fluorescent Lamps</p> <p>IES LM-66-14: Electrical and Photometric Measurements of Single-Ended Compact Fluorescent Lamps</p> <p>IES LM-79-08: Approved Method for Electrical and Photometric Measurements of Solid-State Lighting Products, Sections 9, 10 and 12</p> <p>IES LM-80-08: Measuring Lumen Maintenance of LED Light Sources</p> <p>IES LM-80-15: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules</p> <p>IES LM-82-12: Characterization of LED Light Engines and LED Lamps for Electrical and Photometric Properties as a Function of Temperature</p> <p>IES LM-84-14: Measuring Luminous Flux and Color Maintenance of LED Lamps, Light Engines, and Luminaires</p>



Appendix B





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