Light is OSRAM

OSRAM
Opto Semiconductors

DURIS® E 2835
White (CCT 2200 K – 6500 K)

IES LM-80-08 Test Report

Test Documentation No.:
180343W1 (Document no. 68.184.18.0902.01) – 23rd Jul 2018

TEST REPORT OF IES LM-80-08

IES Approved Method for Measuring Lumen Maintenance of LED Light Sources

Report reference No. :	68.184.18.0902.01
Date of issue :	2018-07-16
Project handler :	Sky Feng
Testing laboratory :	TÜV SÜD Certification and Testing (China) Co., Ltd. Shenzhen Branch
Address :	Building 12&13, Zhiheng Wisdomland Business Park, Nantou Checkpoint Road 2, Nanshan District, 518052 Shenzhen, CHINA
Testing location :	TÜV SÜD Certification and Testing (China) Co., Ltd. Shenzhen Branch
Client :	OSRAM Opto Semiconductors (Malaysia) Sdn. Bhd
Address :	Free Industrial Zone, Phase 1, 11900 Bayan Lepas, Penang, Malaysia
Standard :	This TÜV SÜD test program is based on the following requirements: IES LM-80-08 IES TM-21-11
TRF originated by :	TÜV SÜD Product Service GmbH, Mr. Jason Fu
Copyright blank test report :	This test report is based on the content of the standard (see above). The test report considered selected clauses of the a.m. standard(s) and experience gained with product testing. It was prepared by TÜV SÜD Product Service GmbH. TUV SUD Group takes no responsibility for and will not assume liability for damages resulting from the reader's interpretation of the reproduced material due to its placement and context.
Test procedure :	☐ TÜV Mark ☒ without certification
Non-standard test method :	N/A
National deviations :	N/A
Number of pages (Report) :	18 (Including the Attachment)
Number of pages (Attachments) :	12
Compiled by : Sky Feng (+ signature)	Approved by : Jason Yan (+ signature)

Type of test object ..... :	E2835
Trade mark ..... :	--
Model and/or type reference ..... :	GWJTLMSX. EM
Rating(s) ..... :	DC 60mA (Vf < DC 5.0V)
Manufacturer ..... :	Same as Client.
Address..... :	Same as Client.
Date of order..... :	2015-06-25 and 2018-07-16
Date of receipt of test item ..... :	2015-06-25
Date(s) of performance of test ..... :	2015-06-25 to 2016-09-01

Attachments:

1. Test data;
2. Table of TM-21;
3. Test Equipment List.

General remarks:

"(See remark #)" refers to a remark appended to the report.
"(See appended table)" refers to a table appended to the report.
Throughout this report a point is used as the decimal separator.
The test results presented in this report relate only to the object tested.
This report shall not be reproduced except in full without the written approval of the testing laboratory.
Measurement uncertainty budgets have been determined for applicable test methods and are available upon request.

*: According to "Addendum A for LM-80-08" which issued by IES at 2014-01-09, this addendum replaces Section 4.4.2 in IES LM-80-08. As follows:

4.4.2 Temperature and Humidity

Operation of the LED light sources between photometric measurements shall be at a minimum of two case temperatures, Ts. The case temperature and drive current should be selected by taking into account the LED light sources' intended applications, the manufacturer's recommended operating parameters, and the eventual use of the testing data. At least one of the selected case temperatures shall be 55 °C or 85 °C. These case temperatures are commonly used for industry testing to support direct product comparisons of testing results. The drive current may be different for the different case temperatures. However, performing interpolation per IES TM-21-11 to predict luminous flux maintenance at temperatures between two case temperatures requires the same drive current for the two case temperatures. Testing at three or more temperatures offers more accurate interpolations and a measured value at an intermediate temperature to crosscheck against interpolated results based on higher and lower case temperatures.

During life testing, Ts shall be maintained at a temperature that is greater than or equal to 2°C below the corresponding nominal case temperature. Surrounding air should be maintained at a temperature that is greater than or equal to 5°C below the corresponding nominal case temperature. Humidity shall be maintained to less than 65 RH throughout the life test.

"Addendum A for LM-80-08": http://www.ies.org/PDF/Erratas/LM-80-Addendum-A.pdf

TÜV SÜD Certification and Testing (China) Co., Ltd Shenzhen Branch is an accredited Test Laboratory (NVLAP Lab Code: 500067-0) to IES LM-80:2008 by NVLAP (National Voluntary Laboratory Accreditation Program).

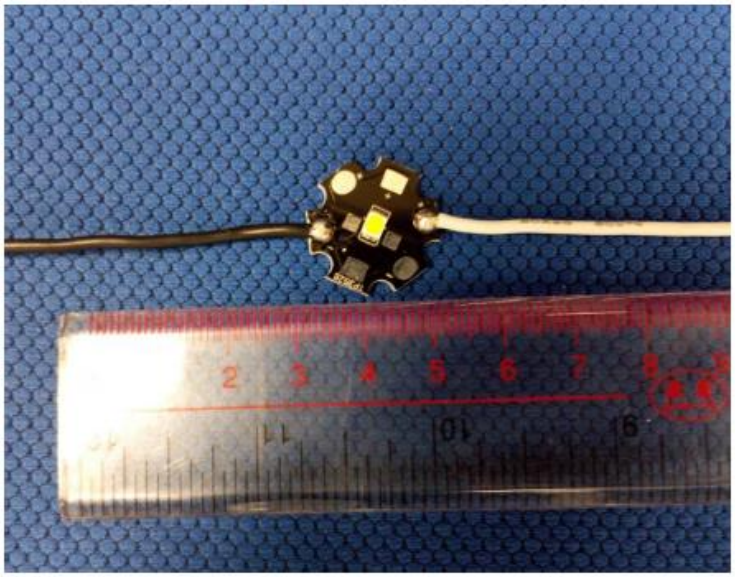
NVLAP® TESTING NVLAP LAB CODE 500067-0

The report must not be used by the client to claim product certification, approval or endorsement by NVLAP, NIST or any agency of the federal government.

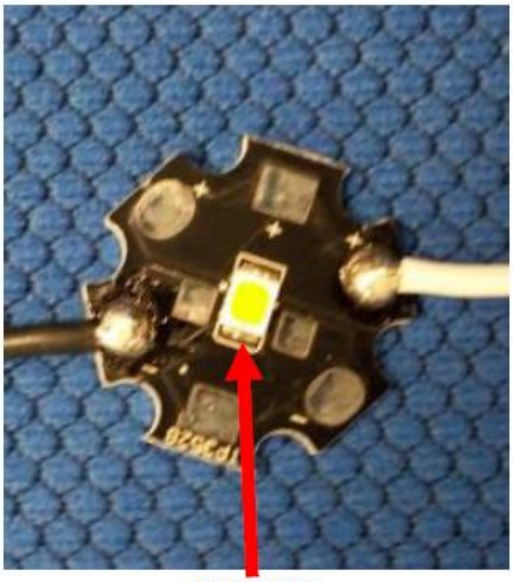
Summary of testing:

	LM-80 Required Temperature		Manufacturer Specified Temperature
	I. 55°C	II. 85°C	III. 100°C
Number of LED tested	25	25	25
Rated Drive current [I_F] (mA)	60	60	60
Actual Temp. [T_S] (°C)	55.0	85.0	100.0
Actual Ambient Temp. [T_A] (°C)	54.2	83.6	98.9
Avg. Lumen maintenance at 6,000 hours (%)	98.32%	98.17%	98.05%
Avg. Chromaticity Shift (Δu'v')at 6,000 hours	0.0015	0.0016	0.0016
Avg. Lumen maintenance at 9,000 hours (%)	96.08%	95.78%	95.22%
Avg. Chromaticity Shift (Δu'v')at 9,000 hours	0.0023	0.0025	0.0027

Photo Document of product



Measurement Point of [Ts]:



Point of Ts

Possible test case verdicts:

- test case does not apply to the test object: .....: N/A
- test object does meet the requirement.....: P(ass)
- test object does not meet the requirement: .....: F(ail)

Possible suffixes to the verdicts:

- Suffix for detailed information for the client.....: C(omment)
- Suffix for important information for factory inspection...: M(anufacturing)

1.0	**SCOPE**		—
2.0	**REFERENCES**		—
3.0	**DEFINITIONS**		—
4.0	**AMBIENT AND PHYSICAL CONDITIONS**		—
4.1	**General**		—
4.2	**LED Unit Marking**		P
	Unit can be identified by markings or by labels		P
	The identification method is suitable for testing.		P
4.3	**Sample Selection**		P
	Samples are selected to be sufficiently representative of the overall population being tested.		P
4.4	**Environmental Conditions**		P
4.4.1	**Vibration**		P
	Lamps should not be subjected to excessive vibration or shock during life testing.		P
4.4.2	**Temperature and Humidity**		P
	The three case temperatures, Ts, shall be 55°C and 85°C with a third temperature selected by the manufacturer.	The third temperature specified by manufacture is: 100 °C	P
	Case temperatures shall be controlled to -2°C during life testing. The temperature of the surrounding air should be maintained to within -5°C of the case temperature during testing.		P
	Humidity shall be maintained to less than 65RH.		P
4.4.3	**Airflow**		P
	Airflow shall be minimized for proper light source.		P
4.4.4	**Operating Orientation and LED**		P
	The operation orientation for the LED light sources under test should be as specified by the manufacturer.		P
5.0	**ELECTRICAL AND THERMAL CONDITIONS**		—
5.1	**Input Voltage and Current**		P
	Input voltage shall conform to the rated input voltage (rms) and frequency of the driver. When using direct current, dc, and ripple voltage shall not exceed 2% of the dc output voltage.		P
5.2	**Line Voltage Waveshape**		P
	The power supply shall have a voltage waveshape such that the total harmonic distortion does not exceed 3%of the fundamental.		P
5.3	**Input Current Regulation**		P

	The input current shall be monitored and regulated to within ±3% of the rated rms value during life testing and to ±0.5% of the rated rms value during photometric measurements.		P
5.4	**Auxiliary Equipment including Drivers**		N/A
	For LED light source external drivers compliant with manufacture's guidance shall be used.		N/A
5.5	**Case Temperature**		P
	A thermocouple measurement system complying with ASTM E230 Table 1 shall be used to monitor the case temperature. Ts is measured directly on the component a manufacturer designated case temperature measurement point on the LED unit.		P
6.0	**TEST AND MEASUREMENT PROCEDURES**		—
6.1	**Instrumentation**		P
	Total elapsed time uncertainty should be within ±0.5%.		P
6.2	**Photometry Measurement**	See "Attachment 1".	P
6.3	**Photometry Measurement Temperature**	See "Attachment 1".	P
	The ambient temperature during lumen and chromaticity measurements shall be set to 25°C±2°C.		P
7.0	**LUMEN MAINTENANCE TESTING METHOD FOR LED LIGHT SOURCES**		—
7.1	**Lumen Maintenance Testing Duration and Interval**	See "Attachment 1".	P
	The unit shall be driven for at least 6000hours with data collection at a minimum of every 1000hours. 10000hours are preferred for the purposes of improved predictive modelling.		P
7.2	**Operating Cycle**	See "Attachment 1".	P
7.3	**Recording Failures**	See "Attachment 1".	P
7.4	**Chromaticity**	See "Attachment 1".	P
8.0	**TEST REPORT**		—

Addendum A for LM-80-08

	The three case temperatures, Ts, shall be 55°C or 85°C with a second temperature selected by the manufacturer.*	The second temperature specified by manufacture is:___°C	N/A

General conditions for testing and measurement

Data Set 1:	
Required Temperature: (°C)	55.0
Actual Temperature:[T_s] (°C)	55.0
Actual Ambient Temperature:[T_A] (°C)	54.2
Rated Driver Current:(mA)	60
Actual Current:(mA)	60
Air Flow:	Minimal air flow
Failures observed:	None

Data Set 2:	
Required Temperature: (°C)	85.0
Actual Temperature:[T_s] (°C)	85.0
Actual Ambient Temperature:[T_A] (°C)	83.6
Rated Driver Current:(mA)	60
Actual Current:(mA)	60
Air Flow:	Minimal air flow
Failures observed:	None

Data Set 3:	
Manufacture specified Temperature: (°C)	100.0
Actual Temperature:[T_s] (°C)	100.0
Actual Ambient Temperature:[T_A] (°C)	98.9
Rated Driver Current:(mA)	60
Actual Current:(mA)	60
Air Flow:	Minimal air flow
Failures observed:	None

Data Set 1: Lumen Test For Lumen Maintenance				**55°C—LM80 required temperature**									
No.	Sample #	Initial (0 hour)		Lumen maintenance (Unit: lm)									
		LF (lm)	V_F (V)	500 hrs	1000 hrs	2000 hrs	3000 hrs	4000 hrs	5000 hrs	6000 hrs	7000 hrs	8000 hrs	9000 hrs
1	1	22.6	3.08	22.6	22.6	22.5	22.4	22.4	22.2	22.1	22.0	21.8	21.6
2	2	22.5	3.08	22.5	22.4	22.2	21.9	21.9	21.9	22.0	21.8	21.6	21.4
3	3	22.4	3.08	22.3	22.2	22.3	22.4	22.3	22.1	22.0	21.8	21.6	21.5
4	4	22.3	3.08	22.3	22.4	22.5	22.1	22.1	21.9	21.9	21.7	21.5	21.4
5	5	22.3	3.11	22.3	22.4	22.1	22.3	22.4	22.2	22.0	21.8	21.7	21.4
6	6	22.2	3.10	22.6	22.6	22.4	22.1	22.0	21.8	21.6	21.6	21.5	21.3
7	7	22.0	3.07	22.0	22.2	22.1	22.0	22.1	21.9	21.9	21.8	21.6	21.3
8	8	22.2	3.08	22.2	22.3	22.4	22.2	22.0	21.9	21.8	21.6	21.5	21.4
9	9	22.2	3.08	22.2	22.3	22.3	22.1	21.9	21.9	21.8	21.8	21.7	21.6
10	10	22.3	3.08	22.3	22.5	22.4	22.2	22.1	22.2	22.1	22.0	21.8	21.7
11	11	22.3	3.08	22.5	22.4	22.2	22.3	22.4	22.2	22.1	21.9	21.7	21.4
12	12	22.5	3.08	22.5	22.6	22.5	22.4	22.3	22.1	22.0	21.8	21.7	21.3
13	13	22.5	3.08	22.5	22.7	22.6	22.5	22.4	22.2	22.0	21.8	21.9	21.5
14	14	22.2	3.07	22.2	22.2	22.0	21.8	21.9	21.7	21.7	21.6	21.5	21.4
15	15	22.1	3.09	22.1	22.4	22.3	22.1	22.1	21.9	21.8	21.7	21.6	21.3
16	16	22.2	3.07	22.2	22.4	22.6	22.6	22.3	22.0	21.8	21.7	21.5	21.3
17	17	22.0	3.08	22.0	22.1	22.0	21.8	21.9	21.9	21.8	21.8	21.6	21.4
18	18	22.5	3.08	22.5	22.6	22.4	22.3	22.1	22.2	22.0	21.8	21.6	21.4
19	19	21.9	3.08	22.1	21.9	21.8	21.9	22.0	21.8	21.6	21.5	21.4	21.1
20	20	22.1	3.07	22.0	22.3	22.2	22.1	22.0	21.8	21.8	21.8	21.6	21.2
21	21	21.9	3.08	21.9	21.9	21.7	21.7	21.8	21.8	21.9	21.7	21.5	21.4
22	22	22.3	3.07	22.3	22.4	22.1	22.0	22.0	21.9	21.8	21.6	21.5	21.3
23	23	22.3	3.07	22.3	22.3	22.0	21.9	22.0	21.8	21.8	21.6	21.5	21.3
24	24	22.6	3.08	22.5	22.5	22.3	22.1	22.0	22.0	22.1	22.0	21.8	21.5
25	25	22.4	3.08	22.4	22.3	22.2	22.2	22.1	22.2	22.0	21.8	21.6	21.5
n		25	25	25	25	25	25	25	25	25	25	25	25
Mean		22.3	3.08	22.3	22.3	22.2	22.1	22.1	22.0	21.9	21.8	21.6	21.4
Median		22.3	3.08	22.3	22.4	22.3	22.1	22.1	21.9	21.9	21.8	21.6	21.4
δ		0.198	0.009	0.201	0.201	0.228	0.226	0.180	0.162	0.146	0.130	0.121	0.128
Min.		21.9	3.07	21.9	21.9	21.7	21.7	21.8	21.7	21.6	21.5	21.4	21.1
Max.		22.6	3.11	22.6	22.7	22.6	22.6	22.4	22.2	22.1	22.0	21.9	21.7

Data Set 1: Lumen Maintenance ratio (%)				**55°C—LM80 required temperature**									
No.	Sample #	Initial (0 hour)		Lumen maintenance ratio (%)									
		LF (lm)	V_F (V)	500 hrs	1000 hrs	2000 hrs	3000 hrs	4000 hrs	5000 hrs	6000 hrs	7000 hrs	8000 hrs	9000 hrs
1	1	22.6	3.08	99.96	99.87	99.51	99.07	99.07	98.19	97.74	97.30	96.42	95.53
2	2	22.5	3.08	99.96	99.25	98.58	97.25	97.25	97.25	97.69	96.80	95.91	95.03
3	3	22.4	3.08	99.91	99.33	99.78	100.22	99.78	98.88	98.43	97.54	96.64	96.20
4	4	22.3	3.08	99.96	100.27	100.85	99.06	99.06	98.16	98.16	97.27	96.37	95.92
5	5	22.3	3.11	99.91	100.40	99.19	100.09	100.54	99.64	98.74	97.85	97.40	96.05
6	6	22.2	3.10	101.76	101.76	100.95	99.59	99.14	98.24	97.25	97.34	96.89	95.99
7	7	22.0	3.07	99.91	101.09	100.50	100.05	100.50	99.59	99.59	99.14	98.23	96.86
8	8	22.2	3.08	99.95	100.45	100.81	99.91	99.01	98.56	98.11	97.21	96.76	96.31
9	9	22.2	3.08	99.95	100.63	100.50	99.59	98.69	98.69	98.24	98.24	97.79	97.34
10	10	22.3	3.08	99.96	100.90	100.31	99.42	99.06	99.42	98.97	98.52	97.63	97.18
11	11	22.3	3.08	100.81	100.18	99.51	99.96	100.40	99.51	99.06	98.16	97.27	95.92
12	12	22.5	3.08	99.96	100.49	100.04	99.60	98.93	98.27	97.82	96.93	96.49	94.71
13	13	22.5	3.08	99.96	100.98	100.62	100.18	99.78	98.84	97.95	97.06	97.51	95.73
14	14	22.2	3.07	99.95	99.95	99.14	98.24	98.69	97.79	97.79	97.34	96.89	96.44
15	15	22.1	3.09	99.95	101.13	100.77	99.86	99.77	98.96	98.51	98.06	97.61	96.25
16	16	22.2	3.07	99.95	100.77	101.89	101.89	100.72	99.19	98.29	97.84	96.93	96.03
17	17	22.0	3.08	99.91	100.18	99.95	99.05	99.50	99.50	99.05	99.05	98.14	97.23
18	18	22.5	3.08	99.96	100.44	99.38	98.94	98.05	98.49	97.60	96.72	95.83	94.94
19	19	21.9	3.08	100.91	100.05	99.45	99.91	100.27	99.45	98.63	98.08	97.63	96.26
20	20	22.1	3.07	99.95	100.91	100.68	100.23	99.82	98.87	98.87	98.87	97.96	96.15
21	21	21.9	3.08	99.91	99.86	99.18	99.18	99.63	99.63	99.91	99.18	98.26	97.81
22	22	22.3	3.07	99.91	100.22	99.10	98.65	98.61	98.21	97.76	96.86	96.41	95.52
23	23	22.3	3.07	99.96	100.09	98.70	98.25	98.70	97.80	97.80	96.90	96.46	95.56
24	24	22.6	3.08	99.96	99.65	98.89	98.00	97.74	97.56	98.00	97.56	96.67	95.34
25	25	22.4	3.08	99.91	99.42	98.93	98.93	98.26	98.93	98.04	97.15	96.26	95.81
n		25	25	25	25	25	25	25	25	25	25	25	25
Mean		22.3	3.08	100.09	100.33	99.89	99.40	99.24	98.70	98.32	97.72	97.05	96.08
Median		22.3	3.08	99.95	100.27	99.78	99.59	99.07	98.84	98.16	97.54	96.89	96.03
δ		0.198	0.009	0.423	0.597	0.843	0.914	0.882	0.683	0.637	0.754	0.709	0.747
Min.		21.9	3.07	99.91	99.25	98.58	97.25	97.25	97.25	97.25	96.72	95.83	94.71
Max.		22.6	3.11	101.76	101.76	101.89	101.89	100.72	99.64	99.91	99.18	98.26	97.81

Data Set 1: Chromaticity Shift (Δu'v')					**55°C—LM80 required temperature**									
No.	Sample #	Initial (0 hour)			Chromaticity Shift (Δu'v')									
		u'	v'	CCT	500 hrs	1000 hrs	2000 hrs	3000 hrs	4000 hrs	5000 hrs	6000 hrs	7000 hrs	8000 hrs	9000 hrs
1	1	0.2612	0.5323	2707	0.0001	0.0005	0.0013	0.0018	0.0018	0.0015	0.0020	0.0021	0.0023	0.0025
2	2	0.2575	0.5306	2791	0.0001	0.0005	0.0014	0.0017	0.0016	0.0015	0.0021	0.0018	0.0023	0.0022
3	3	0.2571	0.5275	2815	0.0001	0.0004	0.0011	0.0017	0.0016	0.0009	0.0011	0.0021	0.0022	0.0025
4	4	0.2593	0.5281	2764	0.0001	0.0007	0.0008	0.0008	0.0011	0.0011	0.0013	0.0012	0.0024	0.0028
5	5	0.2614	0.5324	2703	0.0001	0.0006	0.0014	0.0010	0.0011	0.0013	0.0015	0.0017	0.0024	0.0028
6	6	0.2644	0.5296	2653	0.0000	0.0004	0.0003	0.0005	0.0008	0.0007	0.0010	0.0019	0.0017	0.0019
7	7	0.2613	0.5323	2705	0.0001	0.0006	0.0002	0.0002	0.0006	0.0005	0.0011	0.0017	0.0024	0.0028
8	8	0.2581	0.5282	2790	0.0001	0.0006	0.0002	0.0010	0.0011	0.0011	0.0009	0.0005	0.0023	0.0026
9	9	0.2616	0.5317	2702	0.0001	0.0006	0.0014	0.0011	0.0012	0.0007	0.0018	0.0014	0.0020	0.0023
10	10	0.2580	0.5283	2790	0.0000	0.0004	0.0012	0.0017	0.0016	0.0012	0.0013	0.0016	0.0019	0.0024
11	11	0.2620	0.5303	2700	0.0001	0.0004	0.0012	0.0017	0.0013	0.0008	0.0017	0.0019	0.0026	0.0026
12	12	0.2600	0.5300	2741	0.0001	0.0005	0.0013	0.0012	0.0014	0.0011	0.0022	0.0018	0.0023	0.0025
13	13	0.2586	0.5279	2780	0.0000	0.0004	0.0012	0.0017	0.0018	0.0011	0.0018	0.0015	0.0014	0.0018
14	14	0.2582	0.5272	2791	0.0001	0.0006	0.0014	0.0014	0.0011	0.0012	0.0013	0.0014	0.0020	0.0026
15	15	0.2604	0.5314	2727	0.0001	0.0007	0.0006	0.0009	0.0009	0.0011	0.0012	0.0015	0.0020	0.0022
16	16	0.2608	0.5299	2725	0.0001	0.0005	0.0013	0.0017	0.0019	0.0014	0.0019	0.0019	0.0025	0.0028
17	17	0.2590	0.5282	2770	0.0001	0.0019	0.0009	0.0008	0.0012	0.0011	0.0013	0.0022	0.0016	0.0022
18	18	0.2608	0.5322	2716	0.0001	0.0006	0.0014	0.0016	0.0014	0.0013	0.0015	0.0017	0.0023	0.0026
19	19	0.2599	0.5295	2745	0.0000	0.0005	0.0013	0.0016	0.0019	0.0009	0.0018	0.0023	0.0019	0.0025
20	20	0.2574	0.5261	2815	0.0001	0.0004	0.0012	0.0018	0.0020	0.0009	0.0017	0.0015	0.0016	0.0019
21	21	0.2602	0.5289	2742	0.0001	0.0013	0.0011	0.0007	0.0011	0.0008	0.0020	0.0021	0.0015	0.0020
22	22	0.2591	0.5293	2762	0.0000	0.0007	0.0004	0.0002	0.0008	0.0007	0.0011	0.0008	0.0012	0.0015
23	23	0.2567	0.5277	2823	0.0001	0.0005	0.0015	0.0016	0.0013	0.0005	0.0007	0.0009	0.0018	0.0020
24	24	0.2591	0.5301	2759	0.0000	0.0006	0.0014	0.0013	0.0010	0.0015	0.0017	0.0020	0.0013	0.0020
25	25	0.2616	0.5317	2702	0.0001	0.0006	0.0013	0.0011	0.0010	0.0012	0.0019	0.0020	0.0018	0.0023
n		25	25	25	25	25	25	25	25	25	25	25	25	25
Mean		0.2597	0.5297	2749	0.0001	0.0006	0.0011	0.0012	0.0013	0.0010	0.0015	0.0017	0.0020	0.0023
Median		0.2599	0.5296	2745	0.0001	0.0006	0.0012	0.0013	0.0012	0.0011	0.0015	0.0017	0.0020	0.0024
σ̄		0.0018	0.0018	43	0.0000	0.0003	0.0004	0.0005	0.0004	0.0003	0.0004	0.0004	0.0004	0.0004
Min.		0.2567	0.5261	2653	0.0000	0.0004	0.0002	0.0002	0.0006	0.0005	0.0007	0.0005	0.0012	0.0015
Max.		0.2644	0.5324	2823	0.0001	0.0019	0.0015	0.0018	0.0020	0.0015	0.0022	0.0023	0.0026	0.0028

Data Set 2: Lumen Test For Lumen Maintenance				**85°C—LM80 required temperature**									
No.	Sample #	Initial (0 hour)		Lumen maintenance (Unit: lm)									
		LF (lm)	V_F (V)	500 hrs	1000 hrs	2000 hrs	3000 hrs	4000 hrs	5000 hrs	6000 hrs	7000 hrs	8000 hrs	9000 hrs
1	26	22.2	3.08	22.2	22.3	22.2	22.1	22.0	22.0	21.8	21.6	21.4	21.2
2	27	22.1	3.07	22.1	22.0	22.0	21.8	21.9	21.8	21.7	21.6	21.5	21.3
3	28	22.1	3.08	22.0	22.2	22.1	22.0	22.0	21.9	21.8	21.7	21.5	21.2
4	29	22.5	3.07	22.5	22.4	22.5	22.1	22.2	22.1	22.1	21.9	21.6	21.3
5	30	22.3	3.08	22.3	22.3	22.1	22.1	22.0	22.0	21.8	21.7	21.6	21.4
6	31	22.2	3.08	22.1	22.0	21.9	21.8	21.9	21.8	21.6	21.5	21.4	21.2
7	32	22.0	3.07	22.0	22.3	22.2	22.3	22.1	21.9	21.7	21.6	21.5	21.2
8	33	22.5	3.08	22.4	22.5	22.3	22.1	22.2	22.1	22.0	21.8	21.6	21.2
9	34	21.9	3.07	21.7	21.9	22.0	21.7	21.5	21.4	21.5	21.4	21.3	21.2
10	35	22.4	3.08	22.4	22.6	22.4	22.1	22.1	21.9	21.8	21.6	21.5	21.2
11	36	21.7	3.07	21.7	21.9	21.8	21.9	21.8	21.6	21.7	21.5	21.3	21.0
12	37	22.0	3.08	22.0	22.1	22.0	22.0	21.9	21.8	21.7	21.6	21.5	21.2
13	38	22.1	3.08	22.1	22.2	22.1	22.0	21.9	21.8	21.7	21.7	21.6	21.3
14	39	22.2	3.08	22.2	22.3	22.2	22.2	22.1	21.9	21.7	21.6	21.4	21.1
15	40	22.4	3.07	22.3	22.5	22.3	22.1	22.1	22.0	21.8	21.6	21.4	21.2
16	41	22.1	3.07	22.1	22.2	22.1	22.0	22.0	21.8	21.6	21.5	21.3	21.1
17	42	22.6	3.08	22.5	22.4	22.3	22.1	22.2	22.1	22.0	21.8	21.5	21.2
18	43	22.2	3.08	22.2	22.4	22.6	22.3	22.2	22.1	21.9	21.7	21.5	21.1
19	44	22.0	3.07	22.0	22.3	22.4	22.0	22.0	21.8	21.6	21.5	21.4	21.2
20	45	21.8	3.08	21.8	21.7	21.8	21.7	21.7	21.8	21.6	21.5	21.3	21.0
21	46	22.1	3.08	22.1	22.1	22.0	21.8	21.7	21.8	21.7	21.6	21.4	21.3
22	47	22.0	3.08	22.0	22.0	21.8	21.8	21.8	21.6	21.6	21.5	21.4	21.2
23	48	22.1	3.08	22.1	22.3	22.1	22.0	21.9	21.8	21.8	21.7	21.5	21.2
24	49	22.0	3.08	22.0	22.2	22.3	22.1	22.0	21.9	21.8	21.7	21.5	21.3
25	50	22.0	3.08	21.9	22.2	22.1	22.0	21.8	21.7	21.6	21.4	21.3	21.1
n		25	25	25	25	25	25	25	25	25	25	25	25
Mean		22.1	3.08	22.1	22.2	22.1	22.0	22.0	21.9	21.7	21.6	21.4	21.2
Median		22.1	3.08	22.1	22.3	22.1	22.0	22.0	21.8	21.7	21.6	21.5	21.2
σ		0.201	0.003	0.213	0.204	0.208	0.161	0.174	0.168	0.142	0.121	0.098	0.092
Min.		21.7	3.07	21.7	21.7	21.8	21.7	21.5	21.4	21.5	21.4	21.3	21.0
Max.		22.6	3.08	22.5	22.6	22.6	22.3	22.2	22.1	22.1	21.9	21.6	21.4

Data Set 2: Lumen Maintenance ratio (%)				**85°C—LM80 required temperature**									
No.	Sample #	Initial (0 hour)		Lumen maintenance ratio (%)									
		LF (lm)	V_F (V)	500 hrs	1000 hrs	2000 hrs	3000 hrs	4000 hrs	5000 hrs	6000 hrs	7000 hrs	8000 hrs	9000 hrs
1	26	22.2	3.08	100.00	100.72	100.18	99.73	99.28	99.28	98.38	97.47	96.57	95.67
2	27	22.1	3.07	99.95	99.59	99.46	98.55	99.01	98.55	98.10	97.65	97.20	96.29
3	28	22.1	3.08	99.95	100.54	100.23	99.77	99.82	99.32	98.87	98.41	97.51	96.15
4	29	22.5	3.07	99.96	99.78	100.18	98.40	98.84	98.40	98.40	97.51	96.17	94.84
5	30	22.3	3.08	99.96	99.87	98.97	98.97	98.30	98.52	97.63	97.18	96.73	95.84
6	31	22.2	3.08	99.95	99.32	98.87	98.42	98.87	98.42	97.52	97.07	96.61	95.71
7	32	22.0	3.07	99.95	101.23	100.95	101.41	100.50	99.59	98.68	98.23	97.77	96.41
8	33	22.5	3.08	99.91	100.13	99.29	98.40	98.84	98.40	97.95	97.06	96.17	94.39
9	34	21.9	3.07	99.04	100.14	100.50	99.13	98.22	97.76	98.22	97.76	97.30	96.85
10	35	22.4	3.08	99.91	100.89	100.04	98.70	98.48	97.81	97.36	96.47	96.03	94.69
11	36	21.7	3.07	99.91	100.92	100.46	100.92	100.46	99.54	99.91	99.08	98.16	96.77
12	37	22.0	3.08	99.95	100.27	99.86	99.86	99.41	98.96	98.50	98.05	97.59	96.23
13	38	22.1	3.08	99.95	100.63	100.00	99.55	99.00	98.64	98.19	98.19	97.74	96.38
14	39	22.2	3.08	99.95	100.32	99.91	99.91	99.46	98.56	97.66	97.21	96.31	94.96
15	40	22.4	3.07	99.91	100.81	99.78	98.88	98.88	98.43	97.54	96.64	95.75	94.85
16	41	22.1	3.07	99.95	100.05	99.82	99.37	99.37	98.46	97.56	97.11	96.21	95.30
17	42	22.6	3.08	99.91	99.11	98.89	98.00	98.45	98.00	97.56	96.67	95.34	94.01
18	43	22.2	3.08	99.95	100.72	101.85	100.50	100.05	99.59	98.69	97.79	96.89	95.09
19	44	22.0	3.07	99.95	101.27	101.77	99.95	100.00	99.05	98.14	97.68	97.23	96.32
20	45	21.8	3.08	99.95	99.40	99.86	99.40	99.40	99.86	98.95	98.49	97.57	96.20
21	46	22.1	3.08	99.95	99.95	99.55	98.64	98.19	98.64	98.19	97.74	96.83	96.38
22	47	22.0	3.08	100.00	99.86	98.91	98.91	98.91	98.00	98.00	97.55	97.10	96.19
23	48	22.1	3.08	99.95	100.95	100.00	99.55	99.10	98.64	98.64	98.19	97.29	95.93
24	49	22.0	3.08	99.91	100.91	101.46	100.55	100.27	99.64	99.18	98.73	97.82	96.91
25	50	22.0	3.08	99.91	101.23	100.64	100.18	99.27	98.82	98.36	97.45	96.99	96.08
n		25	25	25	25	25	25	25	25	25	25	25	25
Mean		22.1	3.08	99.91	100.30	99.98	99.35	99.16	98.67	98.17	97.66	96.91	95.78
Median		22.1	3.08	99.95	100.29	99.95	99.39	99.05	98.60	98.19	97.65	96.99	96.08
σ		0.201	0.003	0.179	0.617	0.813	0.852	0.662	0.588	0.600	0.646	0.703	0.781
Min.		21.7	3.07	99.04	99.11	97.95	97.51	97.68	96.62	96.17	96.47	95.34	94.01
Max.		22.6	3.08	100.00	101.27	101.85	101.41	100.50	99.86	99.91	99.08	98.16	96.91

Data Set 2: Chromaticity Shift (Δu'v')					**85°C—LM80 required temperature**									
No.	Sample #	Initial (0 hour)			Chromaticity Shift (Δu'v')									
		u'	v'	CCT	500 hrs	1000 hrs	2000 hrs	3000 hrs	4000 hrs	5000 hrs	6000 hrs	7000 hrs	8000 hrs	9000 hrs
1	26	0.2582	0.5266	2795	0.0001	0.0005	0.0014	0.0019	0.0014	0.0012	0.0019	0.0020	0.0018	0.0028
2	27	0.2625	0.5302	2689	0.0001	0.0005	0.0015	0.0017	0.0016	0.0015	0.0021	0.0021	0.0019	0.0025
3	28	0.2584	0.5274	2786	0.0000	0.0004	0.0015	0.0008	0.0009	0.0014	0.0020	0.0017	0.0016	0.0025
4	29	0.2598	0.5319	2737	0.0000	0.0004	0.0014	0.0019	0.0013	0.0012	0.0022	0.0019	0.0017	0.0026
5	30	0.2581	0.5285	2788	0.0001	0.0003	0.0014	0.0019	0.0013	0.0011	0.0019	0.0022	0.0019	0.0019
6	31	0.2581	0.5280	2791	0.0001	0.0007	0.0000	0.0004	0.0005	0.0008	0.0010	0.0012	0.0022	0.0025
7	32	0.2600	0.5289	2745	0.0000	0.0005	0.0015	0.0016	0.0010	0.0013	0.0020	0.0020	0.0025	0.0027
8	33	0.2602	0.5303	2736	0.0001	0.0005	0.0014	0.0018	0.0017	0.0017	0.0014	0.0022	0.0023	0.0025
9	34	0.2597	0.5279	2757	0.0001	0.0005	0.0015	0.0019	0.0019	0.0015	0.0018	0.0024	0.0025	0.0028
10	35	0.2603	0.5313	2730	0.0001	0.0004	0.0014	0.0019	0.0016	0.0014	0.0013	0.0014	0.0018	0.0020
11	36	0.2600	0.5287	2746	0.0001	0.0004	0.0011	0.0015	0.0013	0.0008	0.0006	0.0017	0.0022	0.0026
12	37	0.2592	0.5278	2767	0.0000	0.0004	0.0013	0.0012	0.0013	0.0010	0.0019	0.0022	0.0016	0.0025
13	38	0.2572	0.5306	2798	0.0001	0.0014	0.0008	0.0012	0.0014	0.0016	0.0022	0.0020	0.0023	0.0026
14	39	0.2591	0.5276	2770	0.0001	0.0004	0.0013	0.0018	0.0018	0.0012	0.0020	0.0019	0.0023	0.0026
15	40	0.2590	0.5298	2763	0.0001	0.0004	0.0014	0.0018	0.0012	0.0013	0.0013	0.0023	0.0023	0.0029
16	41	0.2611	0.5307	2716	0.0001	0.0005	0.0014	0.0010	0.0009	0.0013	0.0020	0.0020	0.0017	0.0027
17	42	0.2594	0.5305	2753	0.0001	0.0004	0.0012	0.0016	0.0012	0.0012	0.0009	0.0013	0.0020	0.0026
18	43	0.2601	0.5283	2747	0.0001	0.0004	0.0014	0.0017	0.0018	0.0007	0.0016	0.0012	0.0013	0.0018
19	44	0.2600	0.5296	2743	0.0001	0.0004	0.0013	0.0018	0.0017	0.0011	0.0016	0.0017	0.0016	0.0019
20	45	0.2605	0.5302	2730	0.0001	0.0010	0.0004	0.0008	0.0011	0.0009	0.0019	0.0022	0.0018	0.0019
21	46	0.2590	0.5296	2764	0.0001	0.0005	0.0012	0.0016	0.0017	0.0013	0.0014	0.0015	0.0021	0.0024
22	47	0.2601	0.5307	2737	0.0001	0.0004	0.0012	0.0017	0.0019	0.0018	0.0015	0.0017	0.0020	0.0025
23	48	0.2572	0.5277	2811	0.0001	0.0004	0.0011	0.0017	0.0012	0.0013	0.0016	0.0021	0.0021	0.0030
24	49	0.2605	0.5290	2736	0.0001	0.0005	0.0015	0.0005	0.0012	0.0012	0.0018	0.0017	0.0016	0.0026
25	50	0.2591	0.5296	2761	0.0000	0.0004	0.0014	0.0018	0.0016	0.0011	0.0012	0.0016	0.0021	0.0026
n		25	25	25	25	25	25	25	25	25	25	25	25	25
Mean		0.2595	0.5293	2756	0.0001	0.0005	0.0012	0.0015	0.0014	0.0012	0.0016	0.0019	0.0020	0.0025
Median		0.2596	0.5296	2755	0.0001	0.0004	0.0014	0.0017	0.0013	0.0012	0.0017	0.0019	0.0020	0.0026
δ		0.0012	0.0013	27.83	0.0000	0.0002	0.0004	0.0005	0.0003	0.0003	0.0004	0.0003	0.0003	0.0003
Min.		0.2572	0.5266	2689	0.0000	0.0003	0.0000	0.0004	0.0005	0.0007	0.0006	0.0012	0.0013	0.0018
Max.		0.2625	0.5319	2811	0.0001	0.0014	0.0015	0.0019	0.0019	0.0018	0.0022	0.0024	0.0025	0.0030

Data Set 3: Lumen Test For Lumen Maintenance				**100°C—Manufacturer specified temperature**									
No.	Sample #	Initial (0 hour)		Lumen maintenance (Unit: lm)									
		LF (lm)	V_F (V)	500 hrs	1000 hrs	2000 hrs	3000 hrs	4000 hrs	5000 hrs	6000 hrs	7000 hrs	8000 hrs	9000 hrs
1	51	21.8	3.08	21.8	21.6	21.6	21.5	21.5	21.6	21.4	21.2	21.1	20.8
2	52	21.9	3.07	21.7	21.9	22.0	21.8	21.9	21.8	21.7	21.5	21.3	21.1
3	53	22.3	3.08	22.3	22.4	22.5	22.3	22.2	22.1	22.0	21.7	21.5	21.2
4	54	22.4	3.08	22.4	22.3	22.0	21.9	22.0	22.1	22.1	21.8	21.5	21.3
5	55	22.5	3.08	22.5	22.4	22.3	22.3	22.2	22.1	21.9	21.7	21.3	21.2
6	56	22.2	3.08	22.2	22.0	21.8	21.7	21.6	21.7	21.6	21.5	21.4	21.2
7	57	22.1	3.08	22.1	22.1	22.0	21.8	21.9	21.8	21.7	21.4	21.3	21.2
8	58	22.1	3.07	22.1	22.2	22.3	22.1	22.0	21.9	21.7	21.5	21.3	21.1
9	59	22.4	3.08	22.4	22.3	22.1	22.1	22.1	22.0	21.7	21.5	21.4	21.1
10	60	22.0	3.08	22.0	22.0	21.8	21.6	21.7	21.7	21.7	21.5	21.3	21.1
11	61	22.6	3.08	22.6	22.4	22.4	22.3	22.3	22.1	21.8	21.6	21.4	21.3
12	62	22.0	3.08	22.0	22.1	22.0	21.7	21.8	21.7	21.6	21.4	21.3	20.9
13	63	22.0	3.08	22.0	22.1	22.0	21.8	21.7	21.7	21.6	21.5	21.2	20.8
14	64	22.2	3.09	22.2	22.1	21.9	21.8	21.9	21.8	21.6	21.4	21.3	20.9
15	65	22.0	3.07	22.0	22.0	21.8	21.8	21.8	21.7	21.8	21.7	21.3	21.0
16	66	22.1	3.08	22.0	21.9	21.9	21.7	21.7	21.6	21.5	21.4	21.3	21.1
17	67	22.4	3.08	22.4	22.3	22.2	22.1	22.0	22.0	21.8	21.7	21.4	21.2
18	68	22.2	3.08	22.2	22.0	22.0	21.9	21.8	21.7	21.7	21.6	21.2	21.1
19	69	21.8	3.07	21.7	21.7	21.6	21.6	21.6	21.6	21.5	21.4	21.3	21.0
20	70	21.9	3.08	21.9	21.8	21.9	21.8	21.8	21.7	21.5	21.3	21.2	21.0
21	71	21.8	3.08	21.8	21.8	21.7	21.7	21.7	21.8	21.6	21.5	21.2	21.0
22	72	21.9	3.08	21.9	21.8	21.7	21.6	21.7	21.6	21.5	21.4	21.3	20.8
23	73	22.1	3.08	22.1	22.0	22.0	21.8	21.9	21.8	21.6	21.5	21.2	20.8
24	74	22.2	3.08	22.2	22.2	22.0	21.9	21.9	22.0	21.8	21.6	21.2	21.1
25	75	21.9	3.07	21.7	21.9	21.7	21.6	21.8	21.7	21.6	21.4	21.2	20.8
n		25	25	25	25	25	25	25	25	25	25	25	25
Mean		22.1	3.08	22.1	22.1	22.0	21.9	21.9	21.8	21.7	21.5	21.3	21.0
Median		22.1	3.08	22.1	22.1	22.0	21.8	21.8	21.8	21.7	21.5	21.3	21.1
σ		0.226	0.003	0.250	0.212	0.233	0.227	0.192	0.170	0.164	0.138	0.096	0.158
Min.		21.8	3.07	21.7	21.6	21.6	21.5	21.5	21.6	21.4	21.2	21.1	20.8
Max.		22.6	3.09	22.6	22.4	22.5	22.3	22.3	22.1	22.1	21.8	21.5	21.3

Data Set 3: Lumen Maintenance ratio (%)				**100°C—Manufacturer specified temperature**									
No.	Sample #	Initial (0 hour)		Lumen maintenance ratio (%)									
		LF (lm)	V_F (V)	500 hrs	1000 hrs	2000 hrs	3000 hrs	4000 hrs	5000 hrs	6000 hrs	7000 hrs	8000 hrs	9000 hrs
1	51	21.8	3.08	99.91	99.17	99.17	98.71	98.76	99.17	98.26	97.34	96.88	95.50
2	52	21.9	3.07	99.04	100.09	100.59	99.68	99.91	99.68	99.22	98.31	97.39	96.48
3	53	22.3	3.08	99.96	100.22	100.85	99.96	99.51	99.06	98.61	97.27	96.37	95.02
4	54	22.4	3.08	99.96	99.29	98.04	97.59	98.04	98.48	98.66	97.15	95.81	94.92
5	55	22.5	3.08	100.00	99.73	99.33	99.33	98.89	98.44	97.55	96.66	94.88	94.43
6	56	22.2	3.08	100.00	99.41	98.33	97.88	97.43	97.88	97.43	96.98	96.53	95.62
7	57	22.1	3.08	100.00	99.82	99.37	98.46	98.92	98.46	98.01	96.66	96.21	95.75
8	58	22.1	3.07	100.00	100.45	100.86	99.95	99.55	99.05	98.06	97.24	96.34	95.43
9	59	22.4	3.08	99.96	99.55	98.70	98.70	98.62	98.26	96.83	96.03	95.58	94.24
10	60	22.0	3.08	99.95	99.73	99.00	98.09	98.55	98.55	98.55	97.64	96.73	95.82
11	61	22.6	3.08	99.96	99.20	99.29	98.85	98.63	97.96	96.63	95.74	94.86	94.41
12	62	22.0	3.08	99.95	100.45	99.86	98.50	98.96	98.50	98.05	97.14	96.69	94.87
13	63	22.0	3.08	99.91	100.41	99.91	99.00	98.64	98.55	98.09	97.64	96.28	94.46
14	64	22.2	3.09	99.95	99.64	98.83	98.38	98.83	98.38	97.47	96.57	96.12	94.31
15	65	22.0	3.07	100.05	100.00	99.23	99.23	99.32	98.77	99.23	98.77	96.95	95.58
16	66	22.1	3.08	99.91	99.37	99.27	98.37	98.28	97.91	97.46	97.01	96.55	95.65
17	67	22.4	3.08	99.96	99.29	99.06	98.62	98.26	98.17	97.28	96.83	95.49	94.60
18	68	22.2	3.08	99.91	99.14	99.05	98.60	98.06	97.70	97.70	97.25	95.45	95.00
19	69	21.8	3.07	99.91	99.72	99.26	99.26	99.17	99.26	98.81	98.35	97.89	96.51
20	70	21.9	3.08	99.91	99.59	100.14	99.68	99.59	99.22	98.31	97.39	96.94	96.02
21	71	21.8	3.08	99.95	100.23	99.72	99.72	99.68	100.18	99.26	98.81	97.43	96.51
22	72	21.9	3.08	99.95	99.68	99.09	98.63	99.09	98.63	98.17	97.72	97.26	94.98
23	73	22.1	3.08	99.95	99.41	99.59	98.69	99.14	98.69	97.78	97.33	95.97	94.16
24	74	22.2	3.08	99.95	99.91	99.14	98.69	98.47	99.14	98.24	97.34	95.54	95.09
25	75	21.9	3.07	98.99	100.00	99.18	98.72	99.63	99.18	98.72	97.81	96.89	95.06
n		25	25	25	25	25	25	25	25	25	25	25	25
Mean		22.1	3.08	99.88	99.74	99.37	98.83	98.84	98.64	98.05	97.32	96.36	95.22
Median		22.1	3.08	99.95	99.70	99.25	98.70	98.86	98.55	98.07	97.27	96.37	95.06
$\bar{\sigma}$		0.226	0.003	0.257	0.402	0.675	0.609	0.592	0.579	0.692	0.723	0.768	0.702
Min.		21.8	3.07	98.99	99.14	98.04	97.59	97.43	97.33	96.63	95.74	94.86	94.16
Max.		22.6	3.09	100.05	100.45	100.86	99.96	99.91	100.18	99.26	98.81	97.89	96.51

Data Set 3: Chromaticity Shift (Δu'v')					100°C—Manufacturer specified temperature									
No.	Sample #	Initial (0 hour)			Chromaticity Shift (Δu'v')									
		u'	v'	CCT	500 hrs	1000 hrs	2000 hrs	3000 hrs	4000 hrs	5000 hrs	6000 hrs	7000 hrs	8000 hrs	9000 hrs
1	51	0.2611	0.5317	2713	0.0001	0.0005	0.0017	0.0008	0.0009	0.0012	0.0015	0.0022	0.0023	0.0026
2	52	0.2581	0.5277	2795	0.0001	0.0006	0.0013	0.0016	0.0014	0.0014	0.0010	0.0019	0.0025	0.0030
3	53	0.2578	0.5286	2796	0.0001	0.0004	0.0014	0.0010	0.0012	0.0014	0.0020	0.0019	0.0016	0.0026
4	54	0.2599	0.5303	2743	0.0000	0.0005	0.0016	0.0018	0.0017	0.0014	0.0015	0.0017	0.0020	0.0030
5	55	0.2597	0.5301	2747	0.0000	0.0005	0.0018	0.0019	0.0020	0.0014	0.0019	0.0021	0.0021	0.0027
6	56	0.2597	0.5284	2754	0.0000	0.0005	0.0019	0.0012	0.0015	0.0014	0.0023	0.0019	0.0022	0.0028
7	57	0.2581	0.5260	2800	0.0000	0.0013	0.0001	0.0010	0.0011	0.0008	0.0022	0.0016	0.0020	0.0027
8	58	0.2577	0.5278	2801	0.0000	0.0003	0.0015	0.0011	0.0013	0.0013	0.0018	0.0007	0.0015	0.0025
9	59	0.2584	0.5284	2785	0.0001	0.0005	0.0006	0.0012	0.0009	0.0010	0.0021	0.0022	0.0024	0.0027
10	60	0.2605	0.5266	2746	0.0000	0.0005	0.0018	0.0010	0.0013	0.0017	0.0016	0.0021	0.0024	0.0028
11	61	0.2605	0.5312	2727	0.0001	0.0005	0.0018	0.0016	0.0017	0.0012	0.0016	0.0016	0.0017	0.0027
12	62	0.2590	0.5284	2771	0.0001	0.0005	0.0011	0.0019	0.0009	0.0013	0.0020	0.0015	0.0019	0.0026
13	63	0.2606	0.5307	2729	0.0001	0.0007	0.0015	0.0014	0.0011	0.0016	0.0015	0.0014	0.0020	0.0031
14	64	0.2588	0.5291	2771	0.0000	0.0006	0.0019	0.0009	0.0008	0.0011	0.0010	0.0016	0.0019	0.0022
15	65	0.2594	0.5271	2767	0.0000	0.0004	0.0015	0.0025	0.0016	0.0013	0.0013	0.0021	0.0018	0.0026
16	66	0.2596	0.5276	2761	0.0000	0.0007	0.0001	0.0010	0.0005	0.0011	0.0015	0.0016	0.0023	0.0025
17	67	0.2596	0.5315	2746	0.0001	0.0005	0.0015	0.0021	0.0014	0.0014	0.0018	0.0013	0.0023	0.0027
18	68	0.2580	0.5270	2797	0.0000	0.0005	0.0006	0.0011	0.0009	0.0009	0.0013	0.0007	0.0016	0.0026
19	69	0.2583	0.5260	2797	0.0001	0.0005	0.0006	0.0015	0.0014	0.0008	0.0007	0.0020	0.0017	0.0027
20	70	0.2603	0.5286	2742	0.0000	0.0013	0.0001	0.0002	0.0009	0.0008	0.0013	0.0018	0.0022	0.0026
21	71	0.2619	0.5297	2705	0.0001	0.0003	0.0014	0.0022	0.0009	0.0007	0.0011	0.0016	0.0021	0.0029
22	72	0.2608	0.5293	2728	0.0001	0.0006	0.0009	0.0021	0.0018	0.0017	0.0014	0.0017	0.0017	0.0025
23	73	0.2614	0.5299	2713	0.0000	0.0005	0.0017	0.0019	0.0011	0.0011	0.0016	0.0021	0.0024	0.0027
24	74	0.2613	0.5291	2720	0.0001	0.0005	0.0005	0.0009	0.0016	0.0017	0.0019	0.0021	0.0022	0.0029
25	75	0.2582	0.5274	2793	0.0001	0.0006	0.0014	0.0017	0.0010	0.0016	0.0018	0.0020	0.0023	0.0031
n		25	25	25	25	25	25	25	25	25	25	25	25	25
Mean		0.2595	0.5288	2758	0.0001	0.0006	0.0012	0.0014	0.0012	0.0013	0.0016	0.0017	0.0020	0.0027
Median		0.2596	0.5286	2758	0.0001	0.0005	0.0015	0.0013	0.0012	0.0013	0.0016	0.0018	0.0021	0.0027
δ		0.0012	0.0016	30.830	0.0001	0.0002	0.0006	0.0005	0.0004	0.0003	0.0004	0.0004	0.0003	0.0002
Min.		0.2577	0.5260	2705	0.0000	0.0003	0.0001	0.0002	0.0005	0.0007	0.0007	0.0007	0.0015	0.0022
Max.		0.2619	0.5317	2801	0.0001	0.0013	0.0019	0.0025	0.0020	0.0017	0.0023	0.0022	0.0025	0.0031

Table of lumen maintenance

Test Data for 55°C Case Temperature		Test Data for 85°C Case Temperature		Test Data for 100°C Case Temperature	
Time (hours)	Lumen Maintenance (%)	Time (hours)	Lumen Maintenance (%)	Time (hours)	Lumen Maintenance (%)
0	100.00%	0	100.00%	0	100.00%
1000	100.33%	1000	100.30%	1000	99.74%
2000	99.89%	2000	99.98%	2000	99.37%
3000	99.40%	3000	99.35%	3000	98.83%
4000	99.24%	4000	99.16%	4000	98.84%
5000	98.70%	5000	98.67%	5000	98.64%
6000	98.32%	6000	98.17%	6000	98.05%
7000	97.72%	7000	97.66%	7000	97.32%
8000	97.05%	8000	96.91%	8000	96.36%
9000	96.08%	9000	95.78%	9000	95.22%

Assumed *In-Situ* Inputs			
Assumed Drive current for each LED package/array/module (mA):	60		
Assumed *In-situ* case temperature (T_c, °C):	55	85	100
Percentage of initial lumens to project to (e.g. for L_{70}, enter 70):	70		

Table1: Report at each LM-80 Test Condition according to above Assumed *In-Situ* Inputs.

Test Condition 1 - 55°C Case Temp		**Test Condition 2 - 85°C Case Temp**		**Test Condition 3 - 100°C Case Temp**	
Sample size	25	Sample size	25	Sample size	25
Number of failures	0	Number of failures	0	Number of failures	0
DUT drive current used in the test (mA)	60	DUT drive current used in the test (mA)	60	DUT drive current used in the test (mA)	60
Test duration (hours)	9,000	Test duration (hours)	9,000	Test duration (hours)	9,000
Test duration used for projection (hour to hour)	4,000 - 9,000	Test duration used for projection (hour to hour)	4,000 - 9,000	Test duration used for projection (hour to hour)	4,000 - 9,000
Tested case temperature (°C)	55	Tested case temperature (°C)	85	Tested case temperature (°C)	100

Equipment	ID No.	Model	Brand/Manufacturer	Calibration due date
Temperature and Humidity meter	68-1-53-12-019	HR641B	MiEO	2019-02-08
Wind Speed Meter	68-1-11-11-003	471-1	Dwyer	2019-01-03
Digital Power Meter	68-1-32-06-009	WT210	YOKOGAWA	2019-05-01
Integrating sphere test system (small)	68-1-44-12-016	Everfine	Everfine	2019-03-09
Digit Multimeter	68-1-34-08-010	34401A	Agilent	2019-07-14
Oven	68-1-90-12-001	ESPEC	SEG-021H	2018-09-01
Oven	68-1-90-12-002	ESPEC	SEG-021H	2018-09-01
Oven	68-1-90-12-003	ESPEC	SEG-021H	2018-09-01
Data logger	68-1-40-11-030	Agilent	34972A	2018-10-25

END OF TEST REPORT

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Appendix A:
Energy Star® LM-80 Application

ENERGY STAR® LM-80 Cover Page

Administrative Information

Tested subcomponent series	DURIS E 2835
Tested subcomponent model number	GW JTLMSX.EM
Report issue date	2018-07-16
Report revision date (if applicable)	Not Applicable
Testing start date	2015-06-25
Testing completion date	2016-09-01
DUT sampling method	According to ANSI/IES LM-80 Test Method

DUT Identification

DUT manufacturer's name	OSRAM Opto Semiconductors (Malaysia) Sdn. Bhd.
DUT identification	GW JTLMSX.EM
Description of DUT	LED Package

DUT Characteristics

Total input power (W)	0.18
Average current density per LED die (mA/mm^2)	302
Average power density per LED package (W/mm^2)	0.02
Representative CRI (Ra) of the tested sample set	CRI80
Minimum die edge to die edge spacing (mm)	NA

Appendix B:
Lumen Maintenance Projection (IES TM-21-11)

For Information Only!

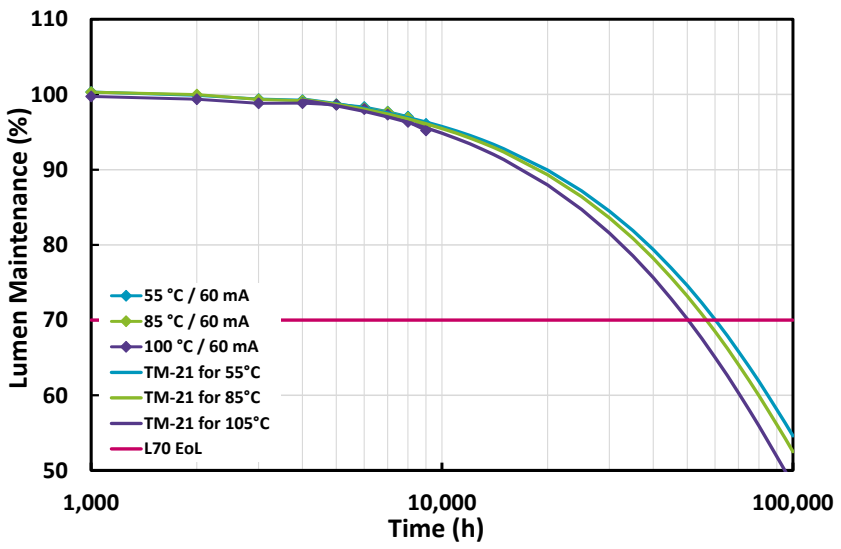
1. General Information

Description of LED light source tested	DURIS® E 2835 GW JTLMSX.EM
Sample size per temperature	25
LED drive current used in the test	60 mA
Test duration	9,000 hours
Test duration used for projection	4,000 hours to 9,000 hours

2. Projection Data

	I	II	III
Case temperature (solder point)	T_S = 55 °C	T_S = 85 °C	T_S = 105 °C
α	6.243E-06	6.646E-06	7.548E-06
B	1.019E+00	1.020E+00	1.023E+00
Reported L70	>54,000 hours	>54,000 hours	50,257 hours

3. Graphic chart



OSRAM
Opto Semiconductors

Appendix C:
Additional Models Covered By Testing

The 28 September 2017 *ENERGY STAR® Requirements for the Use of LM-80 Data* defines conditons for which a LM-80 report is applied to cover models that have not been directly tested.

The test results in this report applies to the following list of models:

- DURIS® E 2835 GW JTLMSX.EM with CCT 2200 K – 6500 K

Disclaimer

Please carefully read the below terms and conditions before using the Information.
If you do not agree with any of these terms and conditions, do not use the Information.

The Information contained in this document does not constitute an independent warranty. The committed behavior is described in the Product data sheet.

Further explanations:
Data: The Data used in this Document consider the reliability test results under the mentioned driving conditions only. For Product information on the maximum operating conditions please refer to the Product data sheet or contact your local sales partner.
Conditions: The conditions for the generation of the data are as follows:
1. The Data and curves shown in this Document are based on experiments carried out under laboratory conditions on a random sample size of LED with readouts at discrete readout times (where applicable). Thus, the Data above represent a limited number of production lots only and may differ between different assembly lots over time (including chip or package changes). Thus, the behavior of the LED in the final application may differ from the Data. The behavior of the LED at conditions or readout times deviating from those stated above may not be deduced from the Data.
2. For long term operation additional failure modes of the chip or package can occur which are not shown in this Document.
3. Possible differences in the thermal management of OSRAM OS and customer's setup may lead to a different aging behavior.
4. The lifetime projection data presented in this Document has been evaluated in accordance with the lifetime extrapolation method described and defined in IES TM-21-11. The lifetime projection is based on the Data shown in this Document. The Data had been collected and assembled according to IES LM-80-08.

END OF DOCUMENT

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