IESNA LM-80-2008

MEASURING LUMEN MAINTENANCE OF LED LIGHT SOURCES

MEASUREMENT AND TEST REPORT

For

Guangzhou Hongli Opto-Electronic Co., Ltd.

No.1, Xianke Yi Road, Huadong Town, Huadu District, Guangzhou, China

Model:HL-LM004H384W-40B18C12(Ra2)

Report Type: 10000 Hours Test Report	**Product Type:** LED Array
Test Engineer:	Daniel Duan
Report Number:	RSZ150309507-10-10000
Test Date:	2015-03-11 to 2016-05-05
Report Date:	2016-05-11
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1 - General Information

1.1 Description of LED Light Sources

Devices tested

Part Number: HL-LM004H384W-40B18C12(Ra2)
Part Type: LED Array
Nominal CCT: 2700K

Family products covered by this report:

According to ENERGY STAR® Program Guidance Regarding LED Package, LED Array and LED Module Lumen Maintenance Performance Data Supporting Qualification of Lighting Products, the following products can be covered by this report base on the declaration letter of manufacturer (see attachment B for more information). The information of these models shows that the covered products meet all section 3 item 7 requirements of ENERGY STAR® Program Guidance Regarding LED Package, LED Array and LED Module Lumen Maintenance Performance Data Supporting Qualification of Lighting Products (September 9, 2011)

Model type	Model name	CCT (typ.)	Series	Parallel	Number of Dies	Power intensity (W/mm2)	Distance between of dies (mm)	Product Specification (mm)	Each Chip Current (mA)
COB-LM004 series	HL-LM004H384W-40B18C12(Ra2) (Test Model)	2700K	12	18	216	0.1025	0.35	28*28	120
COB-LM004 series	HL-LM004H384W-40B18C12(Ra2)	3000K	12	18	216	0.1025	0.35	28*28	120
		4000K	12	18	216	0.1025	0.35	28*28	120
		5000K	12	18	216	0.1025	0.35	28*28	120
		5700K	12	18	216	0.1025	0.35	28*28	120
		6500K	12	18	216	0.1025	0.35	28*28	120
COB-LM004 series	HL-LM004H384W-35B16C12(Ra2)	2700K	12	16	192	0.0911	0.45	28*28	120
		3000K	12	16	192	0.0911	0.45	28*28	120
		4000K	12	16	192	0.0911	0.45	28*28	120
		5000K	12	16	192	0.0911	0.45	28*28	120
		5700K	12	16	192	0.0911	0.45	28*28	120
		6500K	12	16	192	0.0911	0.45	28*28	120
COB-LM004 series	HL-LM004H384W-20B10C12(Ra2)	2700K	12	10	120	0.0735	0.62	28*28	150
		3000K	12	10	120	0.0735	0.62	28*28	150
		4000K	12	10	120	0.0735	0.62	28*28	150
		5000K	12	10	120	0.0735	0.62	28*28	150
		5700K	12	10	120	0.0735	0.62	28*28	150
		6500K	12	10	120	0.0735	0.62	28*28	150
COB-LM004 series	HL-LM004H384W-25B12C12(Ra2)	2700K	12	12	144	0.0854	0.47	28*28	150
		3000K	12	12	144	0.0854	0.47	28*28	150
		4000K	12	12	144	0.0854	0.47	28*28	150
		5000K	12	12	144	0.0854	0.47	28*28	150
		5700K	12	12	144	0.0854	0.47	28*28	150
		6500K	12	12	144	0.0854	0.47	28*28	150
COB-LM004 series	HL-LM004H384W-30B14C12(Ra2）	2700K	12	14	168	0.0996	0.48	28*28	150
		3000K	12	14	168	0.0996	0.48	28*28	150
		4000K	12	14	168	0.0996	0.48	28*28	150
		5000K	12	14	168	0.0996	0.48	28*28	150
		5700K	12	14	168	0.0996	0.48	28*28	150
		6500K	12	14	168	0.0996	0.48	28*28	150

Model type	Model name	CCT (typ.)	Series	Parallel	Number of Dies	Power intensity (W/mm2)	Distance between of dies (mm)	Product Specification (mm)	Each Chip Current (mA)
COB-LM004 series	HL-LM004H384W-25B7C18(Ra2)	2700K	18	7	126	0.0598	1.08	28*28	150
		3000K	18	7	126	0.0598	1.08	28*28	150
		4000K	18	7	126	0.0598	1.08	28*28	150
		5000K	18	7	126	0.0598	1.08	28*28	150
		5700K	18	7	126	0.0598	1.08	28*28	150
		6500K	18	7	126	0.0598	1.08	28*28	150
COB-LM004 series	HL-LM004H384W-17B8C12(Ra2)	2700K	12	8	96	0.0588	1.08	28*28	150
		3000K	12	8	96	0.0588	1.08	28*28	150
		4000K	12	8	96	0.0588	1.08	28*28	150
		5000K	12	8	96	0.0588	1.08	28*28	150
		5700K	12	8	96	0.0588	1.08	28*28	150
		6500K	12	8	96	0.0588	1.08	28*28	150
COB-LM004 series	HL-LM004H384W-50B2C54(Ra2)	2700K	54	2	108	0.0661	0.89	28*28	150
		3000K	54	2	108	0.0661	0.89	28*28	150
		4000K	54	2	108	0.0661	0.89	28*28	150
		5000K	54	2	108	0.0661	0.89	28*28	150
		5700K	54	2	108	0.0661	0.89	28*28	150
		6500K	54	2	108	0.0661	0.89	28*28	150
COB-LM004 series	HL-LM004H384W-40B2C42(Ra2)	2700K	42	2	84	0.0498	1.24	28*28	150
		3000K	42	2	84	0.0498	1.24	28*28	150
		4000K	42	2	84	0.0498	1.24	28*28	150
		5000K	42	2	84	0.0498	1.24	28*28	150
		5700K	42	2	84	0.0498	1.24	28*28	150
		6500K	42	2	84	0.0498	1.24	28*28	150
COB-LM004 series	HL-LM004H384W-24B2C26(Ra2)	2700K	26	2	52	0.0318	1.35	28*28	150
		3000K	26	2	52	0.0318	1.35	28*28	150
		4000K	26	2	52	0.0318	1.35	28*28	150
		5000K	26	2	52	0.0318	1.35	28*28	150
		5700K	26	2	52	0.0318	1.35	28*28	150
		6500K	26	2	52	0.0318	1.35	28*28	150
COB-LM004 series	HL-LM004H384W-30B4C15(Ra2)	2700K	15	4	60	0.0367	0.89	28*28	150
		3000K	15	4	60	0.0367	0.89	28*28	150
		4000K	15	4	60	0.0367	0.89	28*28	150
		5000K	15	4	60	0.0367	0.89	28*28	150
		5700K	15	4	60	0.0367	0.89	28*28	150
		6500K	15	4	60	0.0367	0.89	28*28	150
COB-LM004 series	HL-LM004H384W-40B6C14(Ra2)	2700K	14	6	84	0.0318	1.35	28*28	150
		3000K	14	6	84	0.0318	1.35	28*28	150
		4000K	14	6	84	0.0318	1.35	28*28	150
		5000K	14	6	84	0.0318	1.35	28*28	150
		5700K	14	6	84	0.0318	1.35	28*28	150
		6500K	14	6	84	0.0318	1.35	28*28	150
COB-LM004 series	HL-LM004H384W-50B6C18(Ra2)	2700K	18	6	108	0.0661	0.89	28*28	150
		3000K	18	6	108	0.0661	0.89	28*28	150
		4000K	18	6	108	0.0661	0.89	28*28	150
		5000K	18	6	108	0.0661	0.89	28*28	150
		5700K	18	6	108	0.0661	0.89	28*28	150
		6500K	18	6	108	0.0661	0.89	28*28	150

The family models HL-LM004HXXXW-XBXCX(Ra2) and tested model HL-LM004H384W-40B18C12(Ra2) could meet all the requirements listed as below:

a. the tested model has been conducted on the largest LED array; and,

b. the family models have the equal or fewer LED dies than the tested model;
c. die spacing greater than or equal to the tested model; and,
d. power density (i.e. W/mm2 of PCB or substrate total area, or equivalent calculation) less than or equal to the tested model; and,
e. identical materials used (note: this does not constrain quantity and/or dimensional adjustments); and,
f. identical construction processes used;

Disclaimer:

The truthfulness and accuracy of all the technical information above for the covered LED products is ensured by manufacturer of LED light source. Bay Area Compliance Laboratories Corp. (Dongguan) isn't responsible or gives any guarantees for the truthfulness of the technical information.

1.2 Standards Used:

- IESNA LM-80-08: IES Approved Method for Measuring Lumen Maintenance of LED Light Sources.
- ENERGY STAR® Program Guidance Regarding LED Package, LED Array and LED Module Lumen Maintenance Performance Data Supporting Qualification of Lighting Products(This test method was not accredited by IAS)

1.3 Test Facility

The testing facility used by Bay Area Compliance Laboratories Corp. (Dongguan). is located at Pu Long Cun 69, Puxinghu Industrial Area, Tangxia Town, Dongguan, Guangdong, P.R.China.

1.4 Description of Auxiliary Equipment

Device	Manufacture	Model No	Serial No	Test Range	Calibration date	Calibration due date
1.0m integrating sphere	SENSING	SCD-20008	N/A	N/A	2015-07-17	2016-07-16
spectroradiometer	SENSING	SCD-20008	N/A	N/A	2015-07-17	2016-07-16
DC Power Supply	Hanshenpuyuan	HSPY-100-05	2013010210003	N/A	2015-05-05	2016-05-04
Standard Light Source	EVERFINE	D062	1011093	3000K	2015-09-17	2016-09-16
Multi-channel DC source	Taishan Xingguang	T01000F2	ST04392	0~5V,0~40A	2015-09-17	2016-09-16
Adjustable constant-current DC switching power supply	GUTE	DK-60V50A	120 5037	3000W	2015-09-23	2016-09-22
Digital CC&CV DC Power Supply	EVERFINE	WY5015	11060010	(50/15A)	2016-03-04	2017-03-03

1.5 Operating Cycle

Samples are driven with a constant direct current (DC)

1.6 Ambient Conditions

For lumen maintenance test, samples were operated in thermal chambers with minimal ambient airflow. For long term reliability test, the case temperature was controlled by mounting several thermocouples on a sample reliability stress board at the designated thermal measurement point, as shown in APPENDIX. The ambient temperature T_A was measured by several thermocouples at a distance of 5 mm above the reliability test board. The relative humidity within chamber was less than 65%.

For photometry measurement, temperature was set to 25℃ ±2℃, RH <65%.

1.7 Photometry Measurement Uncertainty

The uncertainty of the light output measurements is U=1.59% (K=2), at the 95% confidence level. The uncertainty of the correlated color temperature measurements is U=21K (K=2), at the 95% confidence level. This calibration results traceable to the NATIONAL INSTITUTE OF METROLOGY (NIM).

1.8 Sample Set

Sampling Method:
LED samples for IESNA LM-80 testing consist of units built from a minimum of three manufacturing lots with each manufacturing lot built from different wafer lots built on non-consecutive days.
These manufacturing lots are picked to represent a wide parametric distribution.
Each Sample is soldered to all of the reliability stress boards for a given set of IESNA LM-80 tests.

Sample Size:
Total 30Pcs;
Each Ts test condition 15Pcs
The samples tested at Ts 85℃ and T_S 105℃ were received at 2015-03-09 and tested during 2015-03-11 to 2016-05-05. The samples were numbered from 1to 15 and 16 to 30.

Data Set 1: 85℃,2160mA	
Part Number:	HL-LM004H384W-40B18C12(Ra2)
Number of Units:	15
Actual Case Temperature(T_S):	T_S =84.1℃
Actual Ambient Temperature(T_A):	T_A =82.5℃
Life Test Drive Current:	I_F =2160mA
Measurement Current:	I_F = 2160mA

Data Set 2: 105℃, 2160mA	
Part Number:	HL-LM004H384W-40B18C12(Ra2)
Number of Units:	15
Actual Case Temperature(T_S):	T_S =104.5℃
Actual Ambient Temperature(T_A):	T_A =103.1℃
Life Test Drive Current:	I_F = 2160mA
Measurement Current:	I_F = 2160mA

2 - Summary of Test Result

Data Set:	**Data Set 1, 85℃, 2160mA**
Number of Units:	15
Failures Observed:	0
Test Interval and Test Duration:	0h,1000h,2000h,3000h,4000h,5000h,6000h,7000h,8000h, 9000h,10000h
Average. Lumen Maintenance at 7000 hours:	97.23%
Average. Lumen Maintenance at 10000 hours:	96.18%
Average Chromaticity Shift at 7000 hours(Δu'v'):	0.0013
Average Chromaticity Shift at 10000 hours(Δu'v'):	0.0019
Reported TM-21 L_{70} Lifetime:	>55,000 hours

Data Set:	**Data Set 2, 105℃, 2160mA**
Number of Units:	15
Failures Observed:	0
Test Interval and Test Duration:	0h,1000h,2000h,3000h,4000h,5000h,6000h,7000h,8000h, 9000h,10000h
Average. Lumen Maintenance at 7000 hours:	95.38%
Average. Lumen Maintenance at 10000 hours:	93.90%
Average Chromaticity Shift at 7000 hours(Δu'v'):	0.0016
Average Chromaticity Shift at 10000 hours(Δu'v'):	0.0022
Reported TM-21 L_{70} Lifetime:	>55,000 hours

3 - Test Data

3.1 Data Set 1, 85℃, 2160mA (Lumen Maintenance)

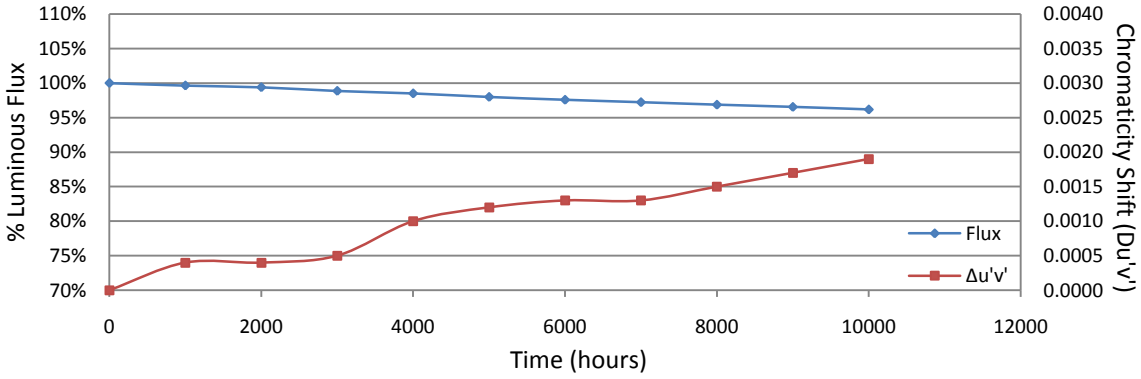
No.	V_F(V)	Φ(lm)	Lumen Maintenance (%)									
	0hr(Initial)		1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs	10000hrs
1	37.22	10353.93	99.25	98.98	98.31	97.80	97.10	96.46	96.20	95.67	95.22	94.90
2	37.25	10182.79	100.30	100.08	99.53	99.28	98.96	98.20	97.94	97.78	96.91	96.62
3	37.13	10641.20	98.86	98.78	98.15	97.81	97.40	97.06	96.81	96.72	96.16	95.75
4	37.21	10268.36	99.89	99.74	99.62	99.19	98.61	97.91	97.64	97.55	97.34	96.98
5	37.31	10225.58	98.89	98.66	98.12	97.54	97.32	96.85	96.39	96.01	95.94	95.37
6	37.20	10256.14	99.47	99.05	98.55	98.17	97.75	97.61	97.16	96.93	96.54	96.26
7	37.25	10292.81	99.72	99.44	99.38	99.08	98.18	97.91	97.65	96.92	96.91	96.64
8	37.22	10329.48	99.17	99.07	98.16	98.04	97.48	97.44	96.99	96.41	96.04	95.85
9	37.27	10231.69	100.18	99.95	99.41	99.27	98.59	98.49	97.94	97.33	96.90	96.49
10	37.21	10433.39	100.23	99.76	99.03	98.69	97.86	97.62	97.17	96.88	96.50	95.93
11	37.26	10140.01	100.27	100.09	99.74	99.24	98.69	98.03	97.67	97.09	97.01	96.51
12	37.29	10146.12	100.62	100.41	99.62	99.21	98.88	98.77	98.51	98.49	98.12	97.90
13	37.16	10317.26	98.21	97.68	97.22	97.11	96.82	96.77	96.51	96.09	95.83	95.37
14	37.16	10549.52	99.72	99.46	98.85	98.36	98.19	97.55	97.11	96.86	96.63	96.42
15	37.36	10317.26	99.82	99.69	99.15	98.74	97.95	97.07	96.81	96.30	96.19	95.76
Ave.	37.23	10312.37	99.64	99.39	98.86	98.50	97.99	97.58	97.23	96.87	96.55	96.18
Med.	37.22	10292.81	99.72	99.46	99.03	98.69	97.95	97.61	97.16	96.88	96.54	96.26
st dev	0.06	140.09	0.6630	0.7014	0.7415	0.7221	0.6733	0.6566	0.6477	0.7325	0.7016	0.7445
Min.	37.13	10140.01	98.21	97.68	97.22	97.11	96.82	96.46	96.20	95.67	95.22	94.90
Max.	37.36	10641.20	100.62	100.41	99.74	99.28	98.96	98.77	98.51	98.49	98.12	97.90

TM-21 Projection:

Test Duration: 10,000 hours
Failures Observed: 0
α: 3.679E-06
β: 0.998
Calculated L_{70}: 96,000 hours
Reported L_{70}: >55,000 hours

3.2 Data Set 1, 85℃, 2160mA (Chromaticity Shift)

No.	u'	v'	CCT(K)	Chromaticity Shift (Δu'v')									
	0hr(Initial)			1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs	10000hrs
1	0.2627	0.5288	2690	0.0006	0.0009	0.0011	0.0018	0.0023	0.0020	0.0023	0.0027	0.0030	0.0033
2	0.2630	0.5299	2680	0.0004	0.0006	0.0009	0.0017	0.0018	0.0018	0.0019	0.0016	0.0014	0.0014
3	0.2630	0.5295	2680	0.0004	0.0007	0.0009	0.0011	0.0013	0.0013	0.0013	0.0017	0.0025	0.0029
4	0.2645	0.5286	2654	0.0004	0.0005	0.0009	0.0011	0.0013	0.0016	0.0017	0.0017	0.0023	0.0024
5	0.2637	0.5294	2668	0.0005	0.0005	0.0014	0.0013	0.0016	0.0018	0.0018	0.0016	0.0014	0.0014
6	0.2655	0.5293	2632	0.0001	0.0002	0.0004	0.0011	0.0014	0.0015	0.0016	0.0018	0.0018	0.0020
7	0.2636	0.5297	2668	0.0003	0.0001	0.0003	0.0010	0.0011	0.0009	0.0011	0.0017	0.0019	0.0021
8	0.2641	0.5292	2660	0.0004	0.0005	0.0001	0.0007	0.0008	0.0013	0.0012	0.0017	0.0019	0.0022
9	0.2632	0.5295	2678	0.0006	0.0005	0.0002	0.0009	0.0010	0.0015	0.0013	0.0012	0.0011	0.0013
10	0.2630	0.5291	2684	0.0002	0.0000	0.0004	0.0009	0.0014	0.0018	0.0016	0.0013	0.0013	0.0014
11	0.2626	0.5272	2700	0.0004	0.0002	0.0002	0.0009	0.0010	0.0006	0.0005	0.0006	0.0010	0.0013
12	0.2648	0.5290	2648	0.0004	0.0001	0.0001	0.0007	0.0008	0.0009	0.0008	0.0017	0.0017	0.0018
13	0.2649	0.5288	2646	0.0005	0.0006	0.0001	0.0004	0.0005	0.0008	0.0009	0.0009	0.0010	0.0012
14	0.2634	0.5297	2672	0.0004	0.0004	0.0005	0.0003	0.0007	0.0009	0.0008	0.0011	0.0014	0.0020
15	0.2624	0.5299	2694	0.0003	0.0002	0.0005	0.0006	0.0010	0.0009	0.0010	0.0015	0.0019	0.0019
Ave.	0.2636	0.5292	2670	0.0004	0.0004	0.0005	0.0010	0.0012	0.0013	0.0013	0.0015	0.0017	0.0019
Med.	0.2634	0.5293	2672	0.0004	0.0005	0.0004	0.0009	0.0011	0.0013	0.0013	0.0016	0.0017	0.0019
st dev	0.0009	0.0007	19.2853	0.0001	0.0003	0.0004	0.0004	0.0005	0.0004	0.0005	0.0005	0.0006	0.0006
Min.	0.2624	0.5272	2632	0.0001	0.0000	0.0001	0.0003	0.0005	0.0006	0.0005	0.0006	0.0010	0.0012
Max.	0.2655	0.5299	2700	0.0006	0.0009	0.0014	0.0018	0.0023	0.0020	0.0023	0.0027	0.0030	0.0033



3.3 Data Set 2, 105 ℃, 2160mA (Lumen Maintenance)

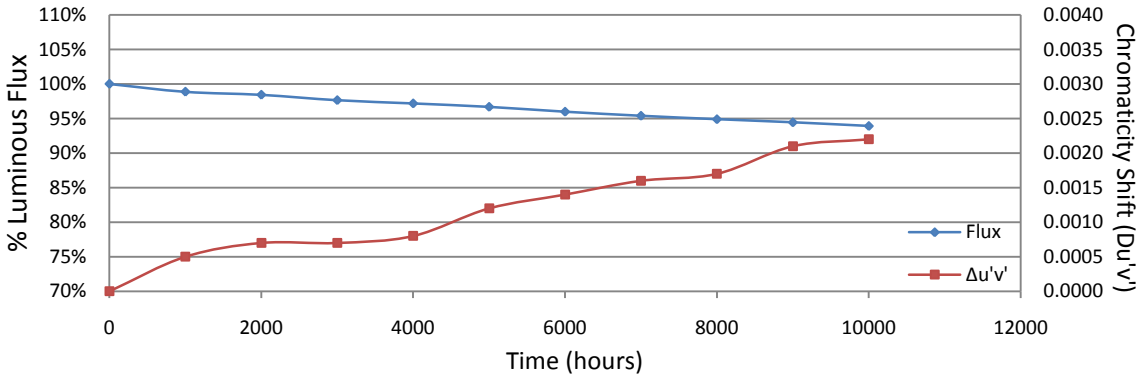
No.	V_F(V)	Φ(lm)	Lumen Maintenance (%)									
	0hr(Initial)		1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs	10000hrs
16	37.12	10573.97	98.90	98.68	97.71	97.47	96.79	96.20	95.68	94.95	94.58	93.88
17	37.37	10121.67	101.68	101.16	100.43	99.78	98.99	98.15	97.60	97.56	97.50	97.09
18	37.15	10390.61	97.85	97.55	97.09	96.34	95.60	94.94	94.41	93.73	93.70	93.46
19	37.33	10140.01	100.88	100.53	99.80	99.48	98.87	98.52	97.98	97.32	96.81	96.17
20	37.20	10121.67	98.61	98.09	97.52	96.99	96.56	95.61	95.06	95.00	94.45	94.31
21	37.13	10647.32	99.39	98.67	97.70	96.98	96.24	95.42	94.90	94.70	93.92	93.15
22	37.07	10628.98	98.06	97.68	97.45	96.97	96.53	95.58	95.06	94.58	94.17	93.61
23	37.17	10421.17	98.63	98.22	97.66	97.13	96.74	95.93	95.40	94.52	94.11	93.41
24	37.13	10384.49	98.24	98.19	96.96	96.52	96.37	95.48	94.95	94.39	94.20	93.74
25	37.18	10378.38	98.50	98.25	97.51	96.78	96.13	95.42	94.88	94.68	93.83	93.24
26	37.07	10616.75	98.18	97.50	96.71	96.47	96.28	95.81	95.01	94.74	93.80	93.17
27	37.06	10586.19	97.29	96.72	96.51	95.79	95.11	94.47	93.95	93.33	92.84	92.33
28	37.15	10439.50	98.12	97.39	96.20	96.03	95.92	95.34	94.81	93.90	93.62	93.30
29	37.15	10396.72	98.46	98.10	97.03	96.76	96.49	96.03	95.12	94.69	94.36	93.85
30	37.19	10402.83	100.13	99.63	98.39	98.11	97.48	96.67	95.92	95.15	94.54	93.83
Ave.	37.16	10416.68	98.86	98.42	97.64	97.17	96.67	95.97	95.38	94.88	94.43	93.90
Med.	37.15	10402.83	98.50	98.19	97.51	96.97	96.49	95.61	95.06	94.69	94.17	93.61
st dev	0.09	178.62	1.1915	1.1963	1.1480	1.1447	1.0636	1.0905	1.0835	1.1494	1.1977	1.2088
Min.	37.06	10121.67	97.29	96.72	96.20	95.79	95.11	94.47	93.95	93.33	92.84	92.33
Max.	37.37	10647.32	101.68	101.16	100.43	99.78	98.99	98.52	97.98	97.56	97.50	97.09

TM-21 Projection:

Test Duration: 10,000 hours
Failures Observed: 0
α: 5.690E-06
β: 0.994
Calculated L_{70}: 62,000 hours
Reported L_{70}: >55,000 hours

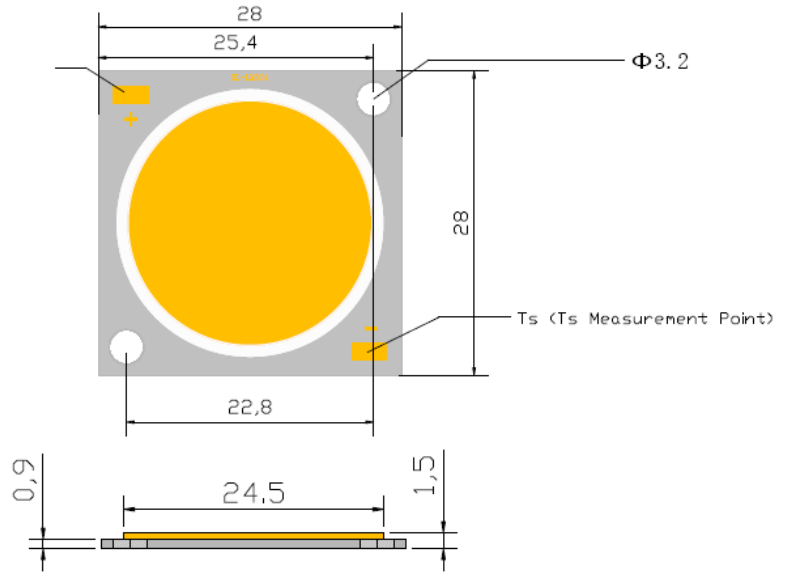
3.4 Data Set 2, 105 ℃, 2160mA (Chromaticity Shift)

No.	u'	v'	CCT(K)	Chromaticity Shift (Δu'v')									
	0hr(Initial)			1000hrs	2000hrs	3000hrs	4000hrs	5000hrs	6000hrs	7000hrs	8000hrs	9000hrs	10000hrs
16	0.2635	0.5299	2670	0.0002	0.0008	0.0009	0.0005	0.0009	0.0009	0.0012	0.0014	0.0021	0.0025
17	0.2632	0.5290	2680	0.0001	0.0004	0.0003	0.0003	0.0013	0.0016	0.0019	0.0016	0.0020	0.0022
18	0.2633	0.5276	2682	0.0003	0.0004	0.0006	0.0007	0.0011	0.0012	0.0015	0.0019	0.0024	0.0026
19	0.2643	0.5298	2654	0.0001	0.0005	0.0006	0.0006	0.0009	0.0011	0.0012	0.0013	0.0015	0.0016
20	0.2645	0.5276	2658	0.0005	0.0008	0.0010	0.0010	0.0016	0.0019	0.0021	0.0026	0.0032	0.0036
21	0.2631	0.5296	2680	0.0002	0.0009	0.0009	0.0009	0.0010	0.0010	0.0012	0.0017	0.0019	0.0018
22	0.2643	0.5303	2652	0.0025	0.0021	0.0021	0.0021	0.0024	0.0024	0.0025	0.0021	0.0021	0.0014
23	0.2627	0.5292	2690	0.0004	0.0004	0.0004	0.0006	0.0010	0.0011	0.0013	0.0016	0.0022	0.0025
24	0.2636	0.5281	2676	0.0006	0.0006	0.0006	0.0007	0.0014	0.0015	0.0017	0.0020	0.0025	0.0024
25	0.2636	0.5292	2670	0.0005	0.0003	0.0007	0.0009	0.0015	0.0019	0.0021	0.0022	0.0026	0.0027
26	0.2643	0.5300	2654	0.0002	0.0007	0.0008	0.0009	0.0010	0.0011	0.0012	0.0013	0.0015	0.0016
27	0.2647	0.5296	2648	0.0005	0.0002	0.0002	0.0004	0.0006	0.0008	0.0011	0.0013	0.0013	0.0012
28	0.2638	0.5299	2664	0.0000	0.0004	0.0004	0.0013	0.0017	0.0019	0.0020	0.0022	0.0024	0.0024
29	0.2641	0.5289	2662	0.0002	0.0007	0.0007	0.0008	0.0010	0.0011	0.0012	0.0014	0.0015	0.0019
30	0.2630	0.5300	2680	0.0003	0.0008	0.0009	0.0009	0.0012	0.0009	0.0010	0.0013	0.0017	0.0018
Ave.	0.2637	0.5292	2668	0.0005	0.0007	0.0007	0.0008	0.0012	0.0014	0.0016	0.0017	0.0021	0.0022
Med.	0.2636	0.5296	2670	0.0003	0.0006	0.0007	0.0008	0.0011	0.0011	0.0013	0.0016	0.0021	0.0022
st dev	0.0006	0.0009	13.0494	0.0006	0.0005	0.0004	0.0004	0.0004	0.0005	0.0005	0.0004	0.0005	0.0006
Min.	0.2627	0.5276	2648	0.0000	0.0002	0.0002	0.0003	0.0006	0.0008	0.0010	0.0013	0.0013	0.0012
Max.	0.2647	0.5303	2690	0.0025	0.0021	0.0021	0.0021	0.0024	0.0024	0.0025	0.0026	0.0032	0.0036



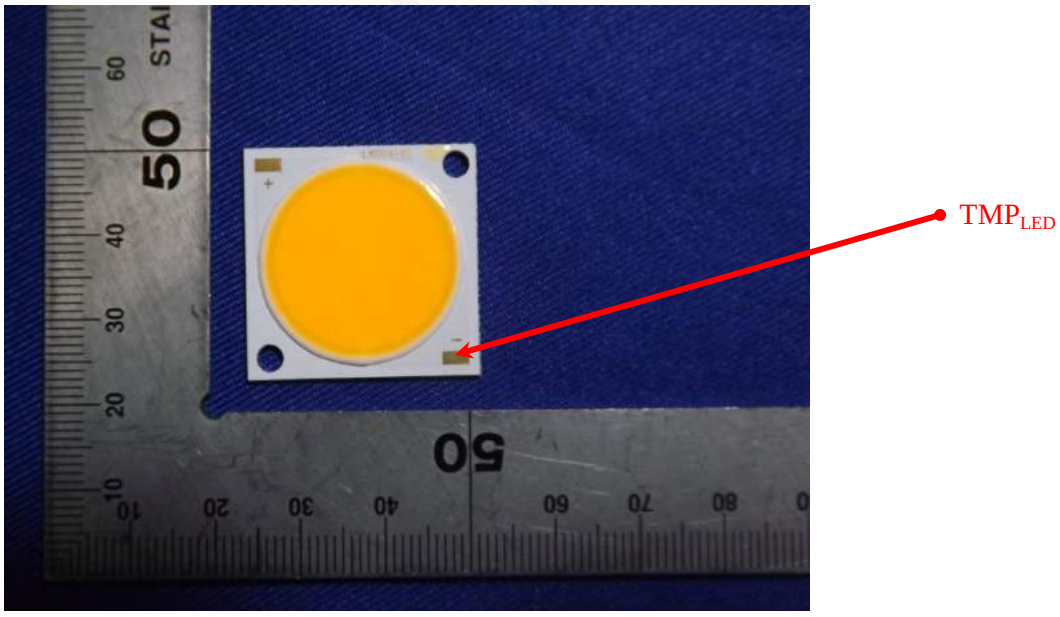
Attachment A – EUT Photo

A.1 Mechanical Dimensions (Ta = 25℃)



All dimensions are in millimeter

A.2 EUT Photo



Attachment B—Family Declaration Letter

Guangzhou Hongli Opto-electronic Co.,Ltd.
No.1,Xianke Yi Road, Huadong Town, Huadu District, Guangzhou

Declaration of Similarity

Current Date: May. 4th,2016

To Whom It May Concern:

GUANGZHOU HONGLI OPTO-ELECTRONIC CO., LTD., a series of LED COB products, are designed with identical material and construction processes. And the tested model HL-LM004H384W-40B18C12(Ra2) was tested by BACL, the results of which are featured in BACL project: RSZ150309507-10-10000.

The tested model and the other LED COB which attest similarity are designed with identical material and identical construction processes. The differences between the tested model and the other LED COB which attest similarity are only CCT and little parameters. The tested model is the largest LED COB, with the greatest number of LED dies, the smallest die spacing, the greatest power density, and listed in the following table:

Model type	Model name	CCT (typ.)	Series	Parallel	Number of Dies	Power intensity (W/mm2)	Distance between of dies (mm)	Product Specification (mm)	Each Chip Current (mA)
COB-LM004 series	HL-LM004H384W-40B18C12(Ra2)	2700K	12	18	216	0.1025	0.35	28*28	120
COB-LM004 series	HL-LM004H384W-40B18C12(Ra2)	3000K	12	18	216	0.1025	0.35	28*28	120
		4000K	12	18	216	0.1025	0.35	28*28	120
		5000K	12	18	216	0.1025	0.35	28*28	120
		5700K	12	18	216	0.1025	0.35	28*28	120
		6500K	12	18	216	0.1025	0.35	28*28	120
COB-LM004 series	HL-LM004H384W-35B16C12(Ra2)	2700K	12	16	192	0.0911	0.45	28*28	120
		3000K	12	16	192	0.0911	0.45	28*28	120
		4000K	12	16	192	0.0911	0.45	28*28	120
		5000K	12	16	192	0.0911	0.45	28*28	120
		5700K	12	16	192	0.0911	0.45	28*28	120
		6500K	12	16	192	0.0911	0.45	28*28	120
COB-LM004	HL-LM004H384W-	2700K	12	10	120	0.0735	0.62	28*28	150

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series	20B10C12(Ra2)	3000K	12	10	120	0.0735	0.62	28*28	150
		4000K	12	10	120	0.0735	0.62	28*28	150
		5000K	12	10	120	0.0735	0.62	28*28	150
		5700K	12	10	120	0.0735	0.62	28*28	150
		6500K	12	10	120	0.0735	0.62	28*28	150
COB-LM004 series	HL-LM004H384W-25B12C12(Ra2)	2700K	12	12	144	0.0854	0.47	28*28	150
		3000K	12	12	144	0.0854	0.47	28*28	150
		4000K	12	12	144	0.0854	0.47	28*28	150
		5000K	12	12	144	0.0854	0.47	28*28	150
		5700K	12	12	144	0.0854	0.47	28*28	150
		6500K	12	12	144	0.0854	0.47	28*28	150
COB-LM004 series	HL-LM004H384W-30B14C12(Ra2)	2700K	12	14	168	0.0996	0.48	28*28	150
		3000K	12	14	168	0.0996	0.48	28*28	150
		4000K	12	14	168	0.0996	0.48	28*28	150
		5000K	12	14	168	0.0996	0.48	28*28	150
		5700K	12	14	168	0.0996	0.48	28*28	150
		6500K	12	14	168	0.0996	0.48	28*28	150
COB-LM004series	HL-LM004H384W-25B7C18(Ra2)	2700K	18	7	126	0.0598	1.08	28*28	150
		3000K	18	7	126	0.0598	1.08	28*28	150
		4000K	18	7	126	0.0598	1.08	28*28	150
		5000K	18	7	126	0.0598	1.08	28*28	150
		5700K	18	7	126	0.0598	1.08	28*28	150
		6500K	18	7	126	0.0598	1.08	28*28	150
COB-LM004 series	HL-LM004H384W-17B8C12(Ra2)	2700K	12	8	96	0.0588	1.08	28*28	150
		3000K	12	8	96	0.0588	1.08	28*28	150
		4000K	12	8	96	0.0588	1.08	28*28	150
		5000K	12	8	96	0.0588	1.08	28*28	150
		5700K	12	8	96	0.0588	1.08	28*28	150

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		6500K	12	8	96	0.0588	1.08	28*28	150
COB-LM004 series	HL-LM004H384W-50B2C54(Ra2)	2700K	54	2	108	0.0661	0.89	28*28	150
		3000K	54	2	108	0.0661	0.89	28*28	150
		4000K	54	2	108	0.0661	0.89	28*28	150
		5000K	54	2	108	0.0661	0.89	28*28	150
		5700K	54	2	108	0.0661	0.89	28*28	150
		6500K	54	2	108	0.0661	0.89	28*28	150
COB-LM004 series	HL-LM004H384W-40B2C42(Ra2)	2700K	42	2	84	0.0498	1.24	28*28	150
		3000K	42	2	84	0.0498	1.24	28*28	150
		4000K	42	2	84	0.0498	1.24	28*28	150
		5000K	42	2	84	0.0498	1.24	28*28	150
		5700K	42	2	84	0.0498	1.24	28*28	150
		6500K	42	2	84	0.0498	1.24	28*28	150
COB-LM004 series	HL-LM004H384W-24B2C26(Ra2)	2700K	26	2	52	0.0318	1.35	28*28	150
		3000K	26	2	52	0.0318	1.35	28*28	150
		4000K	26	2	52	0.0318	1.35	28*28	150
		5000K	26	2	52	0.0318	1.35	28*28	150
		5700K	26	2	52	0.0318	1.35	28*28	150
		6500K	26	2	52	0.0318	1.35	28*28	150
COB-LM004series	HL-LM004H384W-30B4C15(Ra2)	2700K	15	4	60	0.0367	0.89	28*28	150
		3000K	15	4	60	0.0367	0.89	28*28	150
		4000K	15	4	60	0.0367	0.89	28*28	150
		5000K	15	4	60	0.0367	0.89	28*28	150
		5700K	15	4	60	0.0367	0.89	28*28	150
		6500K	15	4	60	0.0367	0.89	28*28	150
COB-LM004 series	HL-LM004H384W-40B6C14(Ra2)	2700K	14	6	84	0.0318	1.35	28*28	150
		3000K	14	6	84	0.0318	1.35	28*28	150
		4000K	14	6	84	0.0318	1.35	28*28	150

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		5000K	14	6	84	0.0318	1.35	28*28	150
		5700K	14	6	84	0.0318	1.35	28*28	150
		6500K	14	6	84	0.0318	1.35	28*28	150
COB-LM004series	HL-LM004H384W-50B6C18(Ra2)	2700K	18	6	108	0.0661	0.89	28*28	150
		3000K	18	6	108	0.0661	0.89	28*28	150
		4000K	18	6	108	0.0661	0.89	28*28	150
		5000K	18	6	108	0.0661	0.89	28*28	150
		5700K	18	6	108	0.0661	0.89	28*28	150
		6500K	18	6	108	0.0661	0.89	28*28	150

The family models HL-LM004HXXXW-XBXCX(Ra2) and tested model HL-LM004H384W-40B18C12(Ra2) could meet all the requirements listed as below:

a. the tested model has been conducted on the largest LED array; and,
b. the family models have the equal or fewer LED dies than the tested model;
c. die spacing greater than or equal to the tested model; and,
d. power density (i.e. W/mm2 of PCB or substrate total area, or equivalent calculation) less than or equal to the tested model; and,
e. identical materials used (note: this does not constrain quantity and/or dimensional adjustments); and,
f. identical construction processes used;

Certified By:

Becky yang

<Contact name>
<Title>
<date>2016-5-5

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**********END OF REPORT**********